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FOREWORD

The Oilseed Processing Clinic is sponsored jointly by the Southern Regional Research Center and the Mississippi Valley Oilseed Processors Association, Inc. The presentations at this Clinic center around "Problems and Progress in the Oilseed Industry." Of special interest are the papers pertaining to problems connected with Occupational Safety and Health Act (OSHA) regulations and the panel discussion on the continuing problem of unaccountable oil losses that occur during processing.

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VOLUNTARY SANITATION GUIDELINES FOR OIL MILLS

By O. J. Jones[1]

My topic is "voluntary sanitation guidelines for oil mills" as opposed to "regulations"—and there is a difference. Official regulations would have the force of law, whereas the industry guidelines under study are intended to assist mills in maintaining a level of sanitation which will meet U.S. Food and Drug Administration (FDA) requirements. No doubt we are going to have to change our way of thinking, because FDA's standards of cleanliness and sanitation are probably higher than we are accustomed to around oil mills.

As you know, the Federal Food, Drug, and Cosmetic Act states that a food is adulterated "if it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food, or if it has been prepared, packed, or held under insanitary conditions whereby it may have been contaminated with filth, or whereby it may have been rendered injurious to health." The act defines food as articles used for food and drink for man or other animals and articles used for components of any such article. FDA considers cottonseed oil mills to be processors of human food because such mills produce crude cottonseed oil, which is used in the production of edible products.

Early oil mill inspections were largely concerned with finding product insanitation, e.g., insect fragments, rodent hair, and bird and rodent excreta. Gradually, more emphasis was given to sanitation practices during processing, handling and storage. Inspectors developed an understanding of conditions that might cause contamination of the product, and they insisted that these be corrected. Most of us found that we could live with these requirements. Overall, they helped us make needed improvements. Most mills now have no great concern about being able to comply with FDA sanitation requirements, and we believe that FDA is rather well satisfied with the improved conditions at most plants.

This situation changed, or offered the prospects of change, when FDA proposed, in the Federal Register of December 15, 1967, regulations which set forth "Good Manufacturing Practices" for sanitation to cover the entire food industry. The intent was to specify the conditions which must prevail to comply with that part of the Food, Drug, and Cosmetic Act which deems a food to be adulterated if it is processed, handled, packed, or stored under insanitary conditions.

The National Cottonseed Products Association officially objected to the regulations on the basis that the human food industry is so diverse that meaningful regulations for one segment would be unnecessarily and unfairly restrictive for other segments. The objection was denied, and on April 26, 1969, the regulations were published. The association petitioned for exemption of crude cottonseed oil mills from the regulations, and several conferences were held. The petition was denied.

FDA officials informed the association staff that the agency would use the proper discretion and judgment in applying these regulations to cottonseed oil mills. The industry was invited to propose an appendix for crude cottonseed oil to the "Good Manufacturing Practices" regulations, which might be used for inspection of our mills. On December 31, 1969, FDA drafted, for consideration by the industry, such specific and supplementary regulations for crude cottonseed oil. This working draft contained requirements that we consider to be entirely unnecessary to achieve cottonseed oil mill sanitation and that are impracticable or even impossible to apply in an oil mill.

These views were discussed with FDA personnel. The association staff was informally told that FDA did not intend to adopt regulations specifically for crude cottonseed oil in the immediate future and suggested that it would find it

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satisfactory for the association to develop, in coordination with FDA personnel, self-regulation guidelines for mills. Such guidelines, according to the thinking of the involved FDA personnel, might evolve to the point that they might be made an official regulation after several years of use.

A committee appointed by the National Cottonseed Products Association has worked with the association staff in the preparation of sanitation guidelines for the crude cottonseed oil industry. The committee is composed of Jack Hughes, J. W. Kidd, J. M. Johnson, L. F. Lucas, Walton Smith, and myself. A number of conferences have been held with FDA officials, who have insisted upon numerous changes in our earlier drafts. On the other hand, we have been able to cause FDA to accept some viewpoints that we consider to be vitally important to the industry.

While each of us objects to one or more of the recommendations in the guidelines, the committee believes mills can live with them. Most, if not all, members of the committee have been and are now opposed to official "Good Manufacturing Practices" regulations. Further, the committee believes that the guidelines at this point are much more reasonable than the regulations would have been. The difference is that with regulations FDA would have the responsibility to draft and industry would only have the privilege to request change. With industry guidelines, industry has had the responsibility to draft, and FDA has retained the privilege to agree or object. Furthermore, industry guidelines can, over a period of years, provide valuable experience that should make regulations more realistic when they do come sometime in the future.

The following guidelines were unanimously recommended by the committee to the board of directors of the National Cottonseed Products Association and were approved by the board on January 11, 1973.

PROPOSED SANITATION GUIDELINES FOR THE CRUDE COTTONSEED OIL INDUSTRY

Preamble

Section 402(a) (4), Federal Food, Drug, and Cosmetic Act, as Amended, sets forth that a food shall be deemed to be adulterated if it (1) consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food, *or* (2) if it has been prepared, packed, or held under insanitary conditions whereby it *may* have become contaminated with filth, or whereby it *may* have been rendered injurious to health.

The general criteria in Part 128, Chapter 1, Title 21, Code of Federal Regulations, entitled "Human Foods: Current Good Manufacturing Practices (Sanitation) in Manufacture, Processing, Packing, or Holding" apply in determining whether the facilities, methods, practices, and controls used in the manufacturing, processing, packing, or holding crude cottonseed oil are in conformance with or are operated or administered in conformity with good manufacturing practices to produce, under sanitary conditions, food destined for human consumption.

Supplemental Federal regulations which would more specifically define current good manufacturing practices for crude cottonseed oil mills have not been issued. In the absence of such, the recommendations set forth in these sanitation guidelines are intended to assist in (1) maintaining a high level of sanitary conditions in the production of crude cottonseed oil, and (2) conforming to the general sanitation criteria of the above referenced "Act" and "Regulations."

Section 1. — Definitions

(a) *Crude Cottonseed Oil Mill.* As used in these guidelines, the term "crude cottonseed oil mill" means a plant which extracts crude cottonseed oil from cottonseed—the seed of the plant *Gossypium*—by mechanical or solvent extraction.

(b) *Crude Cottonseed Oil.* As used in these guidelines, the term "crude cottonseed oil" means the unrefined water-insoluble substance, consisting primarily of triglycerides (but also containing pigments and certain other constituents of the cottonseed) which is derived by a crude cottonseed oil mill from cottonseed and destined for human consumption.

(c) *Destined for Human Consumption.* As used in these guidelines, the phrase "destined for human consumption" means that the triglycerides remaining after crude cottonseed oil is refined, bleached, and deodorized are intended to be consumed as a food by humans. (Note: The

"Act" states, "The term 'food' means (1) articles used for food or drink for man or other animals, (2) chewing gum, and (3) articles used for components of any such articles.")

(d) *Special Foot Covering.* As used in these guidelines, the term "special foot covering" means foot covering, or overcovering which is identified in such a manner that plant management can easily recognize such when worn.

(e) *Special Shoe Cleaning Equipment.* As used in these guidelines, the term "special shoe cleaning equipment" means facilities which will effectively remove foreign material and sanitize the outer surfaces of shoes.

Section 2. — Plant and Grounds

(a) Floors, walls, and ceilings of the plant shall be cleaned as often as necessary to maintain adequate cleanliness. As a minimum, floors in the processing area (seed hulling through oil extraction) shall be cleaned at least once each working day and floors in other areas of the plant shall be cleaned at least once weekly. The mill grounds shall be kept free of accumulations of cottonseed, meal dust and the area should adequately drain.

(b) Effective procedures shall be employed to prevent the presence of rodents, birds, insects, and other vermin within the plant, including warehouses, seedhouses where they may contaminate seed or products being stored, processed, or held. Special care shall be used to protect the press room from flies and other insects. This problem is particularly acute when the mill operates at night. Plant personnel responsible for the sanitation program shall, as a minimum, inspect daily for the presence and/or evidence of insects, birds, rodents, and other vermin and, if found, take immediate action to correct the deficiency. (Note: Screens or hardware metal cloth shall be used where, under workmanlike processing conditions, they do not become easily clogged to the extent that they prevent necessary movement of processing and ventilation air. Exhaust fans may help prevent insect entry where screens are impractical. Insect control may be enhanced by use of safe, effective insecticides and by prevention of accumulation of debris and materials being processed. Safe and effective insecticides and rodenticide baits, properly located outside the processing and storage areas, may be helpful in reducing pest population pressures.)

(c) The following activities shall be conducted in separate rooms or areas:

(1) Delinting and separating.
(2) Pressing and oil extraction.
(3) Storage of chemicals and chemical equipment.
(4) Storage of cottonseed.
(5) Storage of crude oil.
(6) Meal and hull storage and bagging.

Section 3. — Equipment and Utensils

(a) Cookers, presses, and miscellaneous gear boxes of operating equipment shall be constructed and operated so as to prevent contamination of the cottonseed oil with lubricants.

(b) Oil handling equipment such as conveyors, settling tanks, filter presses, screening tanks, and storage tanks shall be located, constructed, and operated so as to preclude adulteration of oil with any contaminant, and shall be so constructed as to be readily accessible for cleaning.

Section 4. — Sanitary Facilities and Controls

(a) Offal, debris, or refuse from any source whatever shall not be allowed to accumulate in or about the plant and shall be removed on a timely basis. Prompt removal of such waste prevents its becoming a harboring and breeding environment for rodents, insects, and other vermin.

(b) Each plant shall provide its employees with adequate toilet and associated hand-washing facilities within the plant or within reasonable proximity to the plant. Toilet rooms shall be furnished with toilet tissue. The facilities shall be maintained in a sanitary condition and kept in good repair at all times. Doors to toilet rooms shall be self-closing and shall not open directly into areas where food is exposed to airborne contamination, except where alternate means have been taken to prevent such contamination (such as double doors, positive airflow systems, etc.). Signs shall be posted directing employees to wash their hands with cleaning soap or detergents after using toilet. Additional hand-washing facilities should be located in processing areas.

Section 5. — Sanitary Operations

(a) Accumulations of warm or moist meats shall be prevented to avoid the possibility of mold and other contamination occurring in conveyors

and other contact surfaces. Self-cleaning conveyors should be adequately maintained to insure the prevention of accumulations. Locations where accumulation tends to occur in other types of conveyors should be cleaned daily unless special cleaning devices such as air blasts are effectively employed to prevent accumulation. All conveyors shall be inspected with sufficient frequency to insure that contaminating accumulations are not occurring. If accumulation is found the conveyor or other contact equipment should be cleaned thoroughly.

(b) Meats handling and oil extracting areas shall be maintained in a sanitary condition through frequent cleaning. Cleaning operations, including the use of pressure air hoses, shall be conducted so as to avoid contamination of the product. In-floor oil troughs should be adequately covered to prevent contamination by floor filth or insects. Vacuum-type cleaners may be preferable to pressure air hoses.

(c) Contaminating materials removed in the seed cleaning process shall not be added back to the seed or meats stream.

Section 6. — Processes and Controls

(a) Where processing areas or equipment are used for processing both technical oils and edible oils, all the requirements regarding crude edible oils shall apply to nonedible oils, except that these guidelines shall not apply to technical oils after they have left the crude oil processing area or equipment.

(b) Burlap bags, cloths, or any other fabric-type material shall not be used to repair leaks in the conveying system or any other equipment.

(c) Seed storage facilities should be located, constructed, and maintained so as to prevent contamination by birds, animals, mold, water, and vermin (including, but not limited to, insects and rodents). Seed which of necessity are stored outside shall be processed as rapidly as possible to minimize contamination and deterioration. Contaminated or deteriorated seed shall not be used.

(d) The product contact surfaces of transport vehicles such as tank trucks or rail cars shall be inspected prior to loading. If contaminants are found, such conveyance shall be cleaned or rejected. Storage tanks for crude oil shall be kept clean.

Section 7. — Personnel

(a) All personnel engaged in handling of cottonseed meats and extraction of oil should maintain a high degree of personal cleanliness including the use of outer garments which are suitable to the work performed and frequently laundered, and use of hats, caps, or other suitable head covering.

(b) Special attention shall be given to prevention of the transport of contamination into oil extraction or press room by footwear. Such contamination should be precluded by use of one of the following procedures. Prominent signs should be posted at each entrance to the press room or oil extraction area to require compliance with the procedure and to provide adequate instructions.

(1) Special foot covering, as defined heretofore, may be worn by each employee while working in the press room or oil extraction areas. These shoes or overcoverings should be removed upon leaving these areas, and they should not be worn in any other area of the plant premises or while off the premises. A convenient and exclusive storage location should be provided for such special foot covering; or

(2) Special shoe cleaning equipment, as defined heretofore, may be provided (with instructions for use) at each entrance to oil extraction or press room areas; or

(3) The oil extraction and press room areas may be restricted to operating personnel whose duties are limited to these areas and to supervisory personnel. When this procedure is the one of choice, signs which prohibit the entry of others and instruct those permitted to enter in the appropriate cleaning of foot wear should be posted at each entrance.

Section 8. — Avoidance of Hazards

(a) No recommendation made in these guidelines should be instituted in such manner that a hazard to the safety and health of employees may be created or pollution of air or water may be caused.

AIR POLLUTION CONTROL IN OILSEED PROCESSING MILLS

By Walter Godchaux, Jr.[1]

The subject of air pollution control in oilseed processing mills is enormous, and I will be able to give but a very brief outline of where we stand today.

Air systems have been in use in cottonseed oil mills for many years, since, in fact, long before my association with the industry. Our company, however, having been in business in the South since 1902, has been associated with oil mills actively since the late 1920's. There are two basic reasons for utilizing air systems in cottonseed oil mills: (1) to move materials from one place to another (e.g., seed conveying systems both to and from the seed cleaning room, lint flue systems and relay systems in the lint room, many other systems in the separating room, as well as meal conveying systems) and (2) to clean up the air. I don't really know, myself, when the earliest air conveying systems were used in cottonseed oil mills. I do know that in the late 1920's the two men who operated the company which is now Nadustco, Inc., Redding Sims and John Rogers, pioneered in the development of dust control systems for the old type delingint machines with individual condensers. The drive for development of these systems was to clean up the lint room, which at that time was very dusty and an almost impossible place to work. A little later lint pickup systems were developed, which saved the trouble of collecting the lint from the condensers in bats and carrying it by hand to the bale press. Of course, in those days little or no lint cleaning was done, the development of lint cleaning having been forced in more recent times by mechanical harvesting methods which have increased the amount of dirt in the cotton lint so that it must be removed to make a salable commodity.

State and Federal laws and regulations affect the use of pneumatic systems in cottonseed oil mills. The basic laws are Federal, relating to preserving and in many cases restoring clean air to the Nation, but so far, it is up to the individual States to enact their own laws, create their own commissions, and issue detailed rules to achieve Federal standards.

Under Federal law, ambient air can have no more than 75 micrograms of particulate matter per cubic meter. This standard does not tell us what emissions are allowable from any given process or stack, and the States are attempting to set limits for individual stacks and plants as a whole based on their contribution to the total pollution as measured upwind and downwind from the plant. (In the few tests I know anything about, some very interesting results have appeared, such as, in some cases, more pollution upwind than downwind.)

Many States have attempted to set process to these standards will meet Federal standards, The setting of these standards originally is based on very complicated formulas for the settling of particulate matter when discharged at certain elevations and certain velocities from stacks under certain assumed wind conditions. I don't think anybody really knows whether adherence to these standards will meet Federal standards, which, I am sure all of you know, will get tougher.

Cyclonic or centrifugal separators, cloth air filters, high-velocity scrubbers, and electrostatic precipitators are used to remove particulate matter from discharged airstreams. Since wet scrubbers are primarily applicable to liquid processes, they have little application to a cottonseed oil mill. About all we would do would be to transfer the problem from one of air pollution to one of water pollution. Electrostatic precipitation has little application to cottonseed oil mills, both because of the expense involved in collection by this method and the fact that in most electrostatic precipitators it is necessary to recover the material through the use of water, which again leads to water pollution problems. For practical pur-

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poses, therefore, cottonseed oil mills are limited to the use of centrifugal and cloth collectors. In most systems in cottonseed oil mills today, cloth collection has serious drawbacks, the primary one being that the collectors are subject to being burned up by fire, and particularly in the lint rooms, fires have not yet been eliminated. There are some places, however, where cloth filter collection will be essential in cleaning up of interior and exterior air pollution in oil mills, and I will mention these places later.

Our company has developed, to the highest state we believe practical at the present time, a high-efficiency centrifugal collector, which we have applied to almost all of the systems in a typical cottonseed oil mill. Setting up to test this type of equipment is so fantastically expensive, and the test themselves are so tedious and expensive in terms of manpower, that very little testing has actually been done. Even after tests are run, it is necessary to apply complicated mathematical formulas to determine whether the effluent from the particular collector or battery of collectors will be sufficiently free of particulate matter to comply with present standards. The results with these formulas depend on the location of the stack with respect to the boundary of a particular plant and the assumptions made as to wind conditions. We have made numerous installations in several States where we have been able to clean up the air discharged from pneumatic systems so that there is no further objection from neighbors and the mills are continuing to operate. Since we are basically engaged in all forms of pneumatic material handling and dust collecting systems we are, of course, giving continual thought to improving the systems we have to offer cottonseed oil mills. We hope some day to be able to solve the problem of absolute dust control in a practical manner. Our high-efficiency pressure collectors are the best we can offer at the moment, and they do seem to be very satisfactory, a great improvement over the old, large, low-velocity centrifugal collectors, which spread tons of dust all over your own plant property, as well as your neighbor's.

Turning now to conditions inside of the mills, we run into the regulations under the Occupational Safety and Health Act. Since I believe there was only recently a hearing on the proposed OSHA standard for cleanliness of air inside of cottonseed oil mills, I won't comment on the OSHA regulations except to point out that I feel that the proposed standard was entirely too low to be achieved at present. We all know, however, that there are many points throughout cottonseed oil mills that are dusty. Today, by and large, lint rooms are quite good where modern linters and lint flue or pneumatic systems are in use. However, there are many other points in the mills that are not as clean as they should be from a standpoint of the workers, and I will try to pick out a few of these points and comment on them.

First, the separating room. It's well known that wherever seed spills onto a screen, there will be airborne dust, light lint, and bran. This problem can be solved by enclosing the feed area of the screen as tightly as possible with a drop curtain at the front of the hood weighted down and dragging on the screen so that a chamber is formed in which the dust can be trapped. This dust can then be picked up by hoods and suction. This method is applicable also at safety shakers, huller shakers, and purifiers. We recommend our high-efficiency pressure collectors for such a system, and the dust can be discharged to the bran bin.

Hull storage, grinding, and bagging can be excessively dusty operations. Hull storage could be improved by dropping the hulls onto a bottomless conveyor where it is to be distributed on the floor of the storage house so the material will always be rolling down itself as it fills the house. Once the hulls build up to the bottom of this conveyor, the rest of the house can be filled with very little dust. If the hulls are stored in a tank or bin, suction can be applied to contain the dust. When hulls are ground to make bran, it is necessary that the material be handled by well-hooded machines with sufficient suction on the grinders so that the hull fibers cannot become airborne. At the bagging operation, suitable floor sweeps should be provided so that any loose hulls can be swept up and returned to hull storage, and proper hooding should be used around the bag-filling operation and under the conveyors on which the bags are handled.

Another very dusty spot has been around the bale presses. Since it is necessary to meet other OSHA requirements, i.e., keeping all doors and other openings around bale pressed closed, it is simple to go a step further and close in these openings with hoods installed on either side of

the tramper to pick up the fine lint and fine dust. By using a suitable amount of air, it is possible to eliminate the press blowing out as the tramper depresses the bale. Also into the same system, floor sweeps can be arranged so that any spillage of lint from the bales as they are discharged from the press can be returned to the lint cleaners. We have installed a number of dust control systems in bale press rooms, and they are very successful.

The meal room, meal storage tanks, meal conveyors, grinders, bagging machines, and even bulk shipping can also be extremely dusty. Of course, all meal storage tanks should have covers, and all conveyors used to handle the meal should be covered and gasketed. Small lines to these points will keep the whole system under a slight negative pressure and prevent the blowout of dust. Screens and meal grinders must be enclosed and kept under sufficient suction so that there will always be a negative pressure on the inside. Boxcars and trucks can be hooded to collect most of the dust forced out with the displaced air from them. If sacking is done, then hooding is required around the sacking spouts, and, of course, any scales must also be enclosed and suction provided. The meal room is one point where we do not recommend our high-efficiency pressure collectors. The particles here are too fine to be handled satisfactorily in a centrifugal collector, and a cloth bag collector should be used. It is important, when cloth bag collectors are used, that the meal should be well precooled before it is stored in order to remove as much moisture as possible and prevent condensation. Moisture and condensation are "poison" to cloth collectors. Either a floor sweep or an opening into a conveyor at or below floor level should be provided in the meal room to take care of any spilled meal. If an opening into a conveyor is used, don't forget that it has to be adequately protected to meet OSHA safety standards. In some systems, in meal rooms where a heavy concentration of meal in the air is encountered, it may be necessary to install a precollector before the cloth collector to reduce the amount of meal going into the cloth collector. Should this be done, the light meal should be returned to storage, rather than being shipped direct, because if this meal is not mixed with the heavy meal, it will create a further dust problem.

I envision an oil mill so clean that a man could walk in in the morning in a blue suit and walk out in the afternoon with that same suit still blue, not white. Other industries have been able, by a lot of hard work and technology, to clean themselves up to this point, and I am sure the oil mill industry can do the same. I assure you that I, personally, and all the people in my company want to work with the industry to this end.

NEW PILOT-PLANT INSTALLATIONS AT THE SOUTHERN REGIONAL RESEARCH CENTER

By James J. Spadaro, Henry L. E. Vix, and Joseph Pominski[1]
(Presented by James J. Spadaro)

Three new installations at the Southern Regional Research Center are a stainless-steel, continuous extractor for oilseeds, an air classifier for cottonseed and peanut flours, and a protein-isolate pilot plant. With the acquisition of this equipment and with equipment on hand, the Center now has what we believe to be one of the best facilities in the country, or perhaps the world, to produce from oilseeds three important edible products: flour with a protein content of 50% to 60%, a protein concentrate with a protein content of 65% to 70%, and protein isolate with a protein content of over 90%.

These modern pilot plants make it possible to evaluate the various parameters that are pertinent in the preparation of the three high-protein oilseed products (flour, concentrates, and isolates), to evaluate the products and produce sufficient quantities of products for their evaluation in food uses by industrial and other organizations, and to coordinate the preparation and evaluation of the products with the needs of industry.

STAINLESS-STEEL, CONTINUOUS EXTRACTOR

The extractor was purchased from the Crown Iron Works. It is about 10 feet high and 13 feet long. It was assembled and pretested at the manufacturer's plant. The extractor has a capacity of 150 lb of flakes per hour, which is equal to about 80–100 lb of meal per hour. The residual lipids will be less than 1%, and the extraction temperature of 140° F will be used.

The extractor includes a drag-conveyor-type chain belt that travels in an oval-shaped loop through six different sections; (1) feeding unit, (2) concurrent extraction, (3) miscella recycling, (4) countercurrent extraction, (5) final recycling and drainage section, and (6) a discharge unit for the extracted flakes. A variable-speed drive permits variation of extraction times from 10 minutes to 10 hours. The extraction and the recycling and drainage sections contain desirable self-cleaning bar-type screens.

Materials with a large amount of fines can be extracted since the initial miscella containing some fines is recycled back on the bed of flakes, which acts as a filter. As the flakes enter the extractor they are subjected to the first of four extraction phases. In the first phase the flakes are mixed with "half-miscella," where the concurrent extraction part takes place. Then, as the flake bed travels horizontally at the bottom of the loop, solvent flows through the flake bed crosswise to the direction of bed movement. This is the recycling or percolation phase. The flake bed then moves upward in the second upright leg of the loop. It is washed by solvent flowing countercurrent to the flakes. The final extraction takes place at the top of the loop where the flake bed has been turned completely over and is subjected to a second percolation phase with fresh solvent.

This extractor will be used to produce both cottonseed and peanut meals that can be ground to a flour or can be further processed to a concentrate or an isolate.

AIR CLASSIFIER

The purpose of air classification is to separate oilseed flours into two fractions, one with a high protein content of about 70% and one with a lower protein content below that of the starting material. The air classification system includes a versatile classifier manufactured by the Majac

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Co.; a pulverizer based on the principle of high-pressure, particle-against-particle impact; an air blower with velocity and volume control; a feeding mechanism; and a high-pressure compressor to supply air necessary for the pulverizer and for the feed mechanism. The versatility of the air classifier is made possible by the several variables available—for example, the speed of the rotor located near the top inside of the classifier, the velocity and volume of air from the compressor, and the movable internal disk that regulates the velocity of the air through an annular space. Other variables are the feed rate and the degree of grinding of the feed material, and the moisture content of the feed material.

The jet pulverizer unit can be used as part of the air classifier or can be operated separately, that is, independently of the air classifier. The high-pressure, particle-against-particle comminution for which the pulverizer is designed, minimizes the breakage of the pigment glands when glanded cottonseed is used. Both the jet pulverizer and a pin mill grinder have been used for glandless cottonseed and peanut meals. Fractions containing up to 70% protein have been produced. If there are hulls or peanut skins in the feed material, these will be separated with the coarse fraction, that is, the fraction with the lower protein content. This classifier has a capacity of about 100 to 150 lb of feed material (flour) per hour.

PROTEIN-ISOLATE PILOT PLANT

This pilot plant is an all stainless-steel installation consisting of several slurry tanks for extracting the protein, two DeLaval desludging centrifuges for separating the solids from the slurry, a pasteurizer, a large spray dryer, and auxiliary equipment, such as two refrigerated tanks and process control equipment. All the pumps, piping and fittings are of sanitary construction, such as those used in milk plants. Other sanitary precautions have been taken. For example, the major units are equipped with a clean-in-place (CIP) system to help prevent bacterial contamination. With this system, chemically treated wash water can be pumped through the plant equipment, which includes tanks, centrifuges, pipes, and pumps. CIP operations are conducted immediately after an experimental run so that the proteinaceous material can be washed away as soon as possible. Before another run, chlorine-treated water is used.

This protein-isolate pilot plant has been designed with great versatility. This will permit investigation of various procedures for preparing isolate from both cottonseed and peanut meals and flours. In the case of cottonseed up to six different procedures for preparing isolates can be investigated.

The pilot plant has a capacity of 50 to 100 lb of protein isolate per 8 hours, including time for starting up and shutting down the plant.

The piping is such that material can be pumped from and to any one of the several tanks and the two centrifuges. The centrifuges are equipped with controls for automatic timing of retention of the materials and for discharging of separated solids. The pasteurizer has two different sections of plate heat exchangers. The first section is for heating of the slurry at controlled times and temperatures, and the second section, for cooling the material.

PROBLEMS CONNECTED WITH OSHA REGULATION COMPLIANCE IN THE OILSEED INDUSTRY

By John E. Heilman[1]

In 1970 the United States Congress passed and on December 29, 1970, the President signed the Williams-Steiger Occupational Safety and Health Act (OSHA). The purpose of the act is to assure as far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources.

To accomplish this purpose, the Secretary of Labor, under whose jurisdiction the Occupational Health and Safety Administration falls, issued in the Federal Register of May 29, 1971, a set of rules and regulations setting the standards that industry must meet. Subsequently, on October 18, 1972, those regulations were brought up to date (Vol. 37, No. 202, Part 2, pp. 22122–22356). It is quite a long thing, about an inch thick, and therein are all the standards under which any plant is inspected.

In the early fall of 1971, my employer, Allied Mills, Inc., appointed a three-man committee consisting of our insurance manager, an occupational safety expert from our insurance brokerage firm, and myself to inspect every company plant to (1) determine the degree of compliance or noncompliance with the standards, (2) initiate immediate correction of any imminent dangers, and (3) determine the cost and time schedule required to put each plant in general compliance with OSHA standards. Our committee then visited the company's 8 poultry and turkey processing complexes, 26 feed mills, 3 dog food plants, 3 alfalfa mills, and 2 siding plants.

Our first concern after each inspection was major violations. These normally would require more than $1,000 each to correct and were most likely to be cited by a Department of Labor compliance officer. Some of these items might be interpreted by a compliance officer as representing imminent danger, which would result in ordering immediate cessation of operations of a machine system, area, or entire plant. On these we recommended immediate corrective action.

Second, we were concerned with minor violations that would require less than $1,000 each to correct by either plant maintenance people or an outside contractor.

Third, we had a category of major and minor items which did not comply with applicable regulations but which were in compliance with accepted State, local, insurance, or corporate standards at the time of installation. A longer period would be required to correct these items.

We had a fourth category of items involving the interpretation of the regulations. Before we visited the plants, we were not sure how to interpret some standards.

The last area of concern was noise.

Our plant inspection showed that there were five major areas of concern that I believe are of interest to oilseed processors.

First, none of our plants met the OSHA regulations for toeboards or railings. It has been my experience that very few, if any, of the plants in our industry did before OSHA. Regulations require a midrail 21 inches above the floor, a top rail at 42 inches, a post every 8 feet, and a toeboard on any platform that is more than 48 inches above grade. The rails must be made of 1½-inch standard pipe or 2×2×⅜ angle iron or 2×4 lumber. Toeboards must be 4 inches high and not clear the floor by more than one-quarter inch.

There is a grandfather clause that allows railings of other than the above materials if the dimensions are kept and the railings will withstand 200 pounds in any direction. Allied Mills installed 400 feet of toeboard at what was then our newest plant. One of our very oldest plants

[1] Senior process engineer, Allied Mills, Inc., 110 North Wacker Dr., Chicago, Ill. 60606.

required 3,000 feet of toeboards and 2,000 feet of railings.

In an oilseed plant some likely areas for inspection are maintenance platforms around legs, conveyors, dryers and so forth, accessibility of bin decks, and preparation building roofs.

Second, the OSHA regulations set up very precise requirements for fixed ladders. They must be at least 16 inches wide, with 15-inch side clearance from the centerline, and have uniformly spaced rungs no more than 12 inches apart. The rungs must clear by 7 inches any construction behind the ladder and by 27 to 30 inches on the side that the man uses. Additionally, with some exceptions, ladders more than 20 feet long require cages and offset landing platforms. We found numerous instances of inadequate ladders in our plants, some of which were corrected. Since the regulation states that offset ladders are required for ascending to work, we have designated all ladders from bin decks to grade and from certain high legs for which other access is not available as being for emergency descent only and have posted signs so stating. However, to legitimately apply this procedure, there must be a legal, in the OSHA sense, means of ascension.

Third, man lifts must meet the standards of the American National Safety Institute. Among the more important requirements of this code are adequate light, emergency landings every 25 feet if floor landings exceed 50 feet, guard coamings, double safeties at the top, railings, including a gate at openings, special sign and lights, remote manual resets, emergency ladder, and an ability to stop under maximum load. The standards for elevators include a requirement for fire resistance that makes compliance with man lift regulations the more attractive alternative. We are putting our man lifts in compliance and are specifying man lifts in new construction in those States that allow them.

Fourth, the OSHA regulations incorporate the National Fire Prevention Association National Electrical Code. This requires, of course, class 2 group G loaders and electrical gear in elevators, feed mills, prep buildings, and meal houses, and class 1 group D in extraction areas. We found numerous minor violations of the National Electrical Code in our soybean plants. We are, however, bringing these plants into strict compliance.

Fifth, and perhaps most important and most perplexing, is finding solutions to noise. The regulations provide the following maximum noise exposure for workers per day: 90 decibels on the A-slow scale, 8 hours; 92 decibels, 6 hours; 95 decibels, 4 hours; 97 decibels, 3 hours; 100 decibels, 2 hours; 102 decibels, 1½ hours; 105 decibels, 1 hour; 110 decibels, one-half hour; and 115 decibels, one-quarter hour. We found the following noise conditions: cracking rolls, 93 to 95 decibels; hull grinders, 103; flaking rolls, 93 to 95; dehulling equipment area, 90 to 93; meal grinding, 92 to 95; extraction plant, not over 90; elevator areas, particularly in the head houses, 92 to 97, with one instance of 102; all vented and most basement areas, less than 90; and grain dryers, as high as 95. We concluded that most areas of our soybean plants were acceptable, but the noise level in some of our elevator areas would limit exposure to 3 hours. Our operators don't spend that much time in these noisy areas. This is less true in a preparation area. I and our soy operations people feel that flaking and cracking operations, in that order, require close observation. We have invested a great deal of money in designing other parts of the plant to achieve acceptable noise levels. We believe, therefore, that isolating the operator to a control room is counterproductive. We hope that flaking and cracking suppliers are studying this problem because we need help.

We found, in addition to the aforementioned five major areas of OSHA violations, numerous small items, which we corrected. Among them were ladders without safety feet, which were replaced or repaired; belt and chain guards missing, which were replaced; exits not designated (exit signs were installed by the hundreds in our plants); and overhead obstructions, which were painted with yellow and black stripes.

We found that the color coding required by OSHA was quite helpful in training operators, so we color-coded all the piping in our extraction plants. All plug-in electrical devices are required to have grounded plugs, and we have corrected those which did not. Guarding and insulating of hot surfaces, which is defined as anything over 140° F, was corrected as necessary. Restricting air pressure to 30 lb/in² is a real problem because this pressure doesn't clean very well. Shields and guards on grinders were conspicuously absent in many locations. In my read-

ing of the OSHA report, it appears that this is one of the most frequent OSHA citations.

I want to mention the relationship of OSHA regulations and National Fire Prevention Association Bulletin No. 36. Section 1910.106 of the regulations sets forth the standards for handling flammable liquid. The thrust of this section is toward storage tank design, layout and hazard control, and structural considerations. The scope portion states that plants built in accordance with NFPA Bulletin No. 36 are not covered by the section. The bulletin covers the design of solvent extraction plants and has a grandfather clause which states that it covers new plants and the modification of existing plants. It seems to me—and I am not a lawyer—that a solvent extraction plant built after 1959, the year that NFPA No. 36 was first published, must by OSHA regulation meet the NFPA standard. Likewise, modifications to existing plants must also be executed in accordance with it.

Among the unusual violations that are rather obscure in the OSHA standards are the following: Dock boards need to be labeled with their capacity. Aisleways in warehouses need to be marked. Piping needs to be color-coded. Material storage must be at least 3 feet from all sprinkler head elevations. Material stored on top of offices, labs, etc. must have railings and toeboards. Positive physical or administrative procedures are called for to prevent switching operations while cars are being loaded, unloaded, or being worked on. Acetylene and oxygen cylinders must be stored separately. Change propane tanks only outdoors. You need guards on windows less than 3 feet from the floor, if the bottom of the window is such that a fall of more than 4 feet is possible. Provide toilets so that no employee need travel more than 200 feet and no more than one floor from his regular workplace.

OSHA AND THE OIL MILL

By Ken L. Chaffe[1]

As you are aware, the oil mill industry is not a "target industry" under the Occupational Safety and Health Act (OSHA). However, like all industries in the country, oil mills are subject to OSHA standards through the "general duty clause." By not being a target industry, oil mills should not be subject to an OSHA inspection except when there is a fatality, an accident involving three or more employees, or a complaint by an employee. This is not totally true, as OSHA inspectors have made walk-in inspections of oil mills and applied the standards where violations were found. We can no longer sit back and feel that we are exempt from inspection.

It is recommended that oil mills institute an OSHA compliance program. This program should include a record of completed and projected work. In addition, mills should keep records of their safety programs, including meetings, personnel training, accident investigation, and management participation. Should you have an OSHA inspection, you should present the inspector with these records, as well as with the OSHA accident logs and summaries, and point out where you have placed the OSHA poster.

To help point out some of the areas that will be checked, I am going to summarize the inspections made in two oil mills in Texas recently. An OSHA inspection begins with a conference between management and the compliance officer. At this time the compliance officer will review records and programs. After the conference, he will proceed with his inspection. There should be a representative of employees and management to accompany him.

Fire extinguishers: checked service date and tag, mountings, markings, and locations.

Electrical installations: checked motor junction boxes, terminals, conduit and general safety conditions, and grounding facilities.

[1] Engineer-agent, Cornwall & Stevens Co., Inc., 314 Nakoma St., San Antonio, Tex. 77843.

Expeller cooker: violation—no guards on V-belts and pulleys (serious) on motors located on top.

Rolls machine: noted guards on drives.

Meal conveyor pit: noted guards on belts and pulleys (7 feet).

Catwalk and ladder on expeller: violation—exposed lightbulbs (serious). Noted air regulator (30 lb/in^2).

Primary cooker: noted safety ladder, guards, cover on conveyor, and electrical installation.

Linter room: noted line shaft linters—typical types of guards that can be used on belts and pulleys.

Overhead line shaft: violations—no guards on bottom of overhead shaft located in walkway (serious) and belts and pulleys not guarded up to 7 feet.

Line shaft belts and pulleys: violations—no guards on belts and pulleys (serious) and no guards on chains and sprockets.

Primary power to line shaft: noted guard.

Linter room: violations—open conveyor end (serious), hydrant located next to open electrical receptical (serious) and 1½ inches of firehose pulled out of window.

Shaker room: noted dustproof electrical boxes, fixed ladder, catwalk, handrails, toeboards, guards on drive, and explosionproof lightbulb covers.

Mixed feed building: checked bagging machine; violations—no guard on horizontal chain drive (serious), and no guard on vertical chain drive.

Meal room: noted platform handrails and toeboards and belt drive guard.

Meal building: checked outside loading platform; violations—ladder located in doorway or passage way (serious) and nonstandard ladder.

Railroad loading area: violation—no means of blocking railroad cars to prevent rollaway (not serious).

Bulk hull loader (railcars): violations—nonstandard ladder (serious), nonstandard platform, no handrails or toeboards, and no guard on belt drive.

Meal storage tanks: violation—no toeboards on elevator catwalk (serious).

Seed house: checked outside suction shed (no dump), housekeeping, and outside firehouses.

Overhead bridge: violation—no toeboards on catwalk (serious).

Locker room/lunch room: divided with concrete block.

Premises: noted housekeeping.

Solvent plant: noted housekeeping and security.

Solvent condenser: checked oil stripper and housekeeping; violations—no toeboards on catwalk (serious), no handrails across back, and no access to top platform.

Oil stripper: violation—no access to catwalk (serious).

Solvent separator: checked housekeeping and maintenance.

Fixed cage ladder.

Solvent storage tank: violation—poor housekeeping (tools, hose, material).

Sump tank.

Cooling tower: existing ladder converted with cage.

Feed conveyor guard: violations—unguarded chain and sprocket (serious) and guard not extended down back of belt and pulley.

Stairs to extractor: violations—unguarded coupling (serious) and poor housekeeping (material on stairs).

Desolventizer: violations—no handrails or toeboards on platform (serious), no access to platform, and no protection across platform opening.

Ladder to extractor: violations—ladder not extended 42 inches above catwalk (serious), no toeboards on catwalk, and ladder not standard width.

Automatic fire extinguisher: violations—broken handrail (serious), no ladder opening in handrail, and toeboards missing in sections.

Explosionproof electrical control room.

Bulk flow to extractor: violations—no toeboards on catwalks (serious), guards not extended down back of belts and pulleys, no means of access to top catwalk, and conveyor access door open.

Bulk flow from extractor: violations—no toeboards on catwalk (serious), guards not extended down back of belts and pulleys, and no access to platform.

Bulk flow: violations—no toeboards on catwalk (serious), no center handrail, no access to platform, and guards not extended down back of belts and pulleys.

Upon completion of the inspection, the compliance officer will meet with management to review his findings, pointing out violations and the standards that apply to them. In most cases, he will leave copies of the standards.

OSHA COMPLIANCE FROM THE U.S. DEPARTMENT OF LABOR VIEWPOINT

By John Parsons[1]

Some of the previous speakers do not seem to be too happy with the Occupational Safety and Health Act, but I feel that their comments in regard to fire hazards, injury, and loss of life illustrate very pointedly why the law was needed. In many cases the standards adopted by OSHA have been available to industry for many years, and we could all have made use of them. We could have used them, that is, had we been able to sell management on the rules and regulations needed to protect employees against such things as fire and injury. But, from some of the preceding comments, I think it is clear that many of your businesses did not follow the standards that you yourselves wrote as an industry.

We in OSHA feel that the law is here to stay. We are in the process of interpreting the law in order to give you better answers as to what the law means and how it affects you individually or the operation in your particular plant. I feel that we will probably tighten the standards and adopt others, depending on the results we have with the present standards.

Variances were previously discussed, and I would like to add my comments. Of course, it is necessary to request them in writing and to explain why the proposed way of doing things is as good as that required by the rules and regulations. Quite a number of variances have been granted rather quickly. I know of one granted in less than 2 months. Remember, though, that if you don't send in enough information to support your request, you will be asked for more. You do not have to make a personal appearance.

Variances can be granted for very simple things, such as one granted to enable an employer to use patented scaffold boards. These boards had been used for years and are much safer than open boards set on a scaffold. Yet, the way the law reads, these patented scaffold boards could not have been used because they did not extend at least 6 inches over the outside edge. In this case, the employer wrote in and very quickly got a variance, which affected his business in all of the Southern States.

I'd like to comment on the subject of imminent danger, which, by the way, we don't see very much of. One of the most common cases involves open trenches, and that, thank goodness, does not apply to your business. But, the point is that we don't go in and order a business to close. Our compliance officers are not allowed to shut down a process or close down a building. Only the Federal courts can order you to shut down. If the compliance officer were not well informed in regard to your business, he would probably first ask you what could happen in a particular case. If he thought it posed an imminent danger, he would ask you to shut down the operation, but not order you to. If you refused, the officer would come to me. If I agreed with him, we would go to the regional office, which in turn would present the case to our solicitors, who would seek a court order. You would then be shut down only until such time as you could show that the operation was safe. I think that is the only way you would want it. We don't go in and arbitrarily shut your business down.

Quite a lot has been made about handrails and toeboards. We have never measured handrails, nor do we measure ladders. If a ladder is obviously dangerous, then, yes, you ought to replace it. But if it is a perfectly good ladder and it will support 200 pounds—and we have no way of testing this in the field as yet—then we do not write a citation. Since we have been in business, not one citation has been issued in Louisiana for the wrong size of handrail. We have cited companies for not having handrails and for not hav-

[1] Area Director, Occupational Safety and Health Administration, U.S. Department of Labor, 546 Carondelet St., New Orleans, La. 70130.

ing midrails or toeboards where they were needed. But just because you have a walkway does not automatically mean that you have to have toeboards. I think that some people feel that anywhere you have a walkway or a handrail you have to have a toeboard, but that is not necessarily correct.

Noise is a problem to some extent. I don't think your operations are as noisy as some other types of business. You realize, of course, that we are asking you to correct noise problems by engineering controls. Many ways have been found to inexpensively reduce noise levels. Where engineering controls are not possible, protection must be provided. If it is not possible to protect employees, administrative controls must be implemented. In that case you switch employees in and out of noisy areas.

We test only the area in which an employee works. We would not take noise readings in a building in which no one works. If an employee were to enter the building, say, for only 15 minutes, then it would be possible to have a very high noise level and still be in compliance. The noise problem can be corrected administratively by moving employees in and out. For instance, in some cases, an employee could work for 4 hours in a noisy area and work outside of the area for 4 hours to complete his workday, and you can thereby achieve compliance.

Color coding was mentioned. Originally, we did enforce the color coding standard. However, we stopped using it almost immediately because there was too much conflict between our standard and that used by various people. It was mentioned that color coding helped in training employees. We are glad to hear that color coding is helpful, and you may use any color coding that you want, but there is no applicable standard.

Air pressure was mentioned. Our standard deals only with air pressure used for cleaning, the maximum being 30 lb/in^2. You can still run equipment at 110 or 120 lb/in^2, and that is necessary with a lot of equipment. In steel processing, in forges, and in other processes, scale builds up on the outside of the hot metal, and the only way to remove it is with air. I believe 120 lb/in^2 is used. Those people were given a variance because they showed that the man doing the work was at the end of a long metal rod through which the air flowed, and he was completely protected with protective clothing. Since no one was endangered, there was no need to require 30 lb/in^2. In other words, look at your process and read the standard very closely. We don't want employees to clean their clothes with air. That practice is dangerous and has caused many injuries in the past.

The target industries were mentioned earlier. We investigate fatalities first and complaints second. If one of your employees sends us a written complaint and the complaint looks valid, we will make an inspection. The target industries are third on the list. It is true that these three keep us busy most of the time, but we are also inspecting general industry and going into plants like yours. So don't be complacent and feel that you have another year or two to prepare. It is important to budget money now and get the plant into compliance with the standards as soon as possible.

Be very careful in interpreting "grandfather" clauses, particularly when you are remodeling a plant. Consider whether the remodeling is such that it could be said to constitute the building of a new plant. There have been quite a few different rulings on what constitutes "repair" and what is "new construction."

DISCUSSION

J. E. HEILMAN:[2] Can you comment on the application of the National Fire Protection Association's Bulletin 36 to OSHA?

MR. PARSONS: I am not very familiar with it, so would prefer not to comment specifically, but any standards that you adopt must be equal to or better than OSHA requirements.

K. L. CHAFFE:[3] A long nozzle or nozzle pipe is the only way to clean lint off the ceiling and the top of machinery. Are you saying that 120 lb/in^2 of air pressure could be used as long as the employee was protected?

MR. PARSONS: If the employee was well protected, you would probably be given a variance. However, if you created a fire hazard, then that is something else.

MR. CHAFFE: Face and respirator?

MR. PARSONS: Probably eye protection and a respirator.

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[2] Senior process engineer, Allied Mills, Inc., Chicago, Ill.

[3] Engineer-agent, Cornwall & Stevens Co., Inc., San Antonio, Tex.

C. L. KINGSBAKER:[4] Color coding is covered in the National Fire Protection Association's Bulletin 36. It states: "All piping and equipment shall be coded for identification. If color coding is used, the following colors are recommended."

When processors say "we can't do this," they usually mean they don't want to spend money to do it. The National Fire Protection Association's position is that economics does not justify unsafe working conditions. If an old plant is in compliance as it is, the plant may not be so situated that it can be expanded and remain in compliance. This is a very key point and a point that is being argued by cottonseed and soybean processors.

FROM THE FLOOR: When can you use catwalks without toeboards?

MR. PARSONS: I believe toeboards are primarily for two things: to keep someone from kicking off a runway onto people or into machinery and to keep a person from slipping off a catwalk. Normally, if nothing is stored on the platform or if nothing could be hurt by having something kicked onto it, then I don't believe you have to have toeboards. I would read that part of the standards very closely to fit your operation.

FROM THE FLOOR: Does a variance for a particular process or procedure have to be issued for every individual company?

MR. PARSONS: Yes. Of course, once a variance for a particular situation is granted, a guideline would have been established, and it would then be very easy for another company to get one. In some cases as many as five or six companies have obtained the same variance. Industrial associations have not been granted variances.

MR. KINGSBAKER: Say that a man is killed in a plant. The plant has never been inspected. What happens then?

MR. PARSONS: The OSHA compliance officer will ask questions about the accident. He will probably go over the company's records. He will go to the scene of the accident and will probably take pictures. He will take statements of witnesses. He will gather all of the information that he can in order to form an opinion as to why the employee was killed. Depending on the size of the plant, the amount of time required, and the time of day, the compliance officer may then inspect the whole plant. Or else the area director may direct him to inspect only the accident and report on it. A general inspection may be scheduled later. Consideration would be given to the size of the plant, whether or not it was part of a target industry, and the like. When the compliance officer has completed the inspection, he will discuss the information he has obtained with management and with the area director. If it is decided that the company is in violation of the standards, a citation will be issued and a penalty sheet prepared. The citation and penalty will then be sent by registered mail to the head of the business.

[4] Manager, Midwest District, Blaw-Knox Chemical Plants, Inc., Pittsburgh, Pa.

BYSSINOSIS: POTENTIAL PROBLEMS RELATING TO COTTONSEED PROCESSING

By George S. Buck, Jr.[1]

I don't know that byssinosis presents problems to the cottonseed processing industry, because that hinges on the question of whether or not byssinosis is associated with raw cotton fiber only. I believe the National Cottonseed Products Association has taken a position that cottonseed processors don't handle raw fiber. They handle linters and they handle seed, but they don't handle raw cotton fiber per se, and the basis of byssinosis, of course, goes back to the handling of the fiber in textile mills.

The standard for byssinosis on which the Occupational Safety and Health Administration (OSHA) is now operating was based on studies in cotton textile mills in England. So, from one standpoint, we might assume that there is a technical possibility at least that oil mills are not affected by byssinosis. I am going to talk about byssinosis, though, as it affects various segments of the industry, the cotton mills, mattress plants, furniture plants, possibly oil mills, and let you draw the conclusion of whether or not you are covered as cottonseed processors. Incidentally, I express the viewpoints of the National Cotton Council, for which I was director of research for many years, since my company is retained by the council.

Byssinosis is a pulmonary dysfunction very much like chronic bronchitis. It is quite difficult to distinguish from bronchitis, emphysema, and some other pulmonary dysfunctions—even from the effect of heavy smoking. However, I think it is clearly established as a definite disease or dysfunction associated with something in vegetable dust. It is encountered in workers in cotton mills, flax mills, hemp processing, etc., who usually experience permanent disability only after exposure for long periods of years, at least 10 years, to rather high levels of dust. But, there is a standard on cotton dust related to byssinosis.

That standard got on the books in a rather funny way. It was buried in a list of toxic substances published by OSHA on August 13, 1971. I don't think any of us in the cotton industry noticed this listing. We had a deadline of 60 days to take that to court, and I am sure that some of us would have, if we had known about it. The standard was based on the extrapolation of a curve developed by the British researchers Shilling and Roach[2] about 12 years ago. This curve plotted incidence of byssinosis against dust levels. The extrapolation of that curve to zero incidence came out to 1 mg/m^3 of air.

Now Shilling and Roach themselves felt it was impractical to have a standard of less than 2½ mg/m^3, but the American Council of Governmental Industrial Hygienists picked this up at some stage and adopted it, and it was incorporated into the Walsh-Healy Act. It was seldom, if ever, enforced, but it thus became a national standard and was adopted by OSHA under the provisions that allow OSHA to incorporate any national standard in its rules. We therefore do have a standard for cotton dust, a "threshold limit value," of 1 mg/m^3 of air.

Now, secondly, cotton has been declared a "target health hazard," along with silica, lead, asbestos, and carbon monoxide. This, too, came as a surprise to the industry. It happened in January 1972. While there is no imminent hazard with cotton dust, and while there is no serious hazard above 3 mg/m^3 and, of course, have long-term exposure, the basis for this decision was apparently that some 800,000 people were estimated to be associated with work assignments in which exposure to cotton dust is a factor.

[1] President, Ramcon, Inc., 223 Scott St., Memphis, Tenn. 38112.

[2] Shilling, R. S. F., and Roach, S. A. 1961. Safe levels of dustiness in cotton spinning mills. Pure Appl. Chem. 3: 69–75.

The problem is not cotton. It is not the cotton fiber, clearly. It is apparently not even cotton dust. There is apparently some toxic factor. We don't know its nature. We don't know whether it is an enzyme, a natural plant particle, a flavonoid, or something else that produces tightness in the chest and shortness of breath, particularly on Monday in textile mills after a worker has been off for the weekend. Usually, these symptoms are picked up on the first day of work.

Textile mills in general are having great difficulty meeting the standard. From what I have seen of processes in oil mills and gins and delinting plants, there are going to be similar difficulties in complying. A little bit contrary to what Mr. Parsons said,[3] the American Textile Manufacturers Institute has submitted a petition for a variance covering a substantial segment of the textile industry (probably 100 or 200 mills), and this petition is now before OSHA. There has been no action on it yet, but perhaps in recognition of the fact that there is no easy way to meet this standard at the moment, the citations have been, let's say, less than intensive and, of course, we hope that this condition continues.

However, we have had citations for other segments of the raw cotton industry handling cotton or cotton fiber products. We have had citations for firms handling linters, and we have had a number of citations for cotton gins. As far as we know, there is no official go-slow policy on byssinosis or on the 1 mg/m^3 dust level.

We feel that most processors cannot now meet the standard. A few firms say they can. We could face an even tighter standard.

There are two agencies involved in this type of health standard. One is NIOSH, the National Institute for Occupational Safety and Health, which is charged with the job of doing research and coming up with new standards. The other is OSHA, which enforces the standards or adopts regulations and then enforces them. Some of the professionals in NIOSH have felt that the standards should apply to respirable dust only. That means the fine particles, probably less than 15 and perhaps as small as 7 μg, picked up with a vertical elutriator. A standard of 0.2 μg/m^3 has been suggested for respirable cotton dust. This in most cases is roughly twice as tough as the present 1-mg/m^3 standard. If changes are made in ventilating equipment and filtration equipment to enable firms to meet the 1-mg/m^3 standard, it is quite likely that those measures would be completely or at least largely ineffective in meeting a standard of 0.2 μg/m^3. OSHA seems to feel that the 1-mg/m^3 standard is tight enough.

Cottonseed processors could be affected by the standard in their own operations and by what happens to customers who use linters along with textile waste. There is an enormous market, as you know, for linters and waste in mattresses, furniture, and automobile cushioning. All of those people who process fiber may also have to meet these standards, and to the extent that they have dust problems and that they have substitute products which they can use, such as polyurethane foam, or to the extent that they have other incentives to move away from cotton because of fire resistance or cigarette susceptibility, cottonseed processors might be looking at smaller markets for their products.

The only real solution to the byssinosis problem is in research. We are getting a good bit of research from Cotton Incorporated. Some individual firms are doing research, and textile manufacturers have been sponsoring research for several years. The only big organization which is not in it to the extent it should be is the U.S. Department of Agriculture.

We recommend that manufacturers take measures toward compliance. Five steps generally agreed upon are as follows: (1) Measure dust levels to which employees are exposed. (2) Institute some medical monitoring of employees to see if any have any respiratory difficulties. This is not usually the case unless an employee has worked in a dusty area for many years, day in and day out. (3) Assign employees sensitive to dust to less dusty areas. (4) In areas where dust levels exceed the threshold limit value, make the use of dust masks or personal protective devices mandatory. (5) Initiate the first steps toward an engineering feasibility study for the abatement of high dust levels. In conversations with OSHA, we have received the opinion in several cases that participation to some degree in research programs leading toward a resolution of the dust problem or the problem of the active factor in dust can be construed as a part of this engineering survey.

The industry will probably explore ways to petition for a variance industrywide. We don't

[3] See "Discussion" in preceding paper.

know whether that can be done or not, but we have a problem which is obviously insoluble immediately. There is no way that all of the firms which use cotton can meet this standard, even if the standard is correct, and so we will be exploring some way to petition for a stay until research can provide the answer.

I think there will be some efforts to seek amendments to OSHA. These amendments may be directed toward the basis on which standards are set. This particular standard was apparently based on some rather slim evidence, not even developed in this country, from a very small sample of mills. More recent work in this country shows a rather low degree of correlation between dust per se and the incidence of byssinosis.

It is possible that the standard may be challenged in court, although the time for this, according to the Williams-Steiger Act, appears to have run out. But at least that possibility will be looked into.

There will be an effort by some segments of the industry to appraise byssinosis from an independent medical viewpoint. We don't dispute the fact that byssinosis is a real dysfunction, but most of the research has been carried out by medical people who have made a career of byssinosis. It might be helpful to have the disease looked at from a slightly more independent viewpoint.

Another subject which should be investigated is the worldwide response to byssinosis. Is this country alone in having a 1-mg/m^3 standard? I suspect that it is, and if other countries throughout the world are not setting a standard at this level, is it reasonable for industries here to have to live with it? We will seek to have the term "cotton dust" revised or changed in the standards. Byssinosis is also associated with dust from flax, from hemp, and probably from many different vegetable products. The dust has even been picked up in raindrops. It seems to apply a special stigma to our industry to have the word "cotton" applied to this vegetable dust.

In conclusion, I would say that we have a serious problem; that your industry needs to be concerned with this problem; that you need to follow what is being done and through your associations support the effort to get some correction to the standards now on the books; and that you need to help buy time so that we can get answers to the problem through research.

I believe there are answers. I believe we will find out what the factor is in cotton dust and other vegetable dust that causes this dysfunction, and that we will succeed in detoxifying it or removing it. That is the target toward which our research is being directed now.

In the meantime, we do need time to get satisfactory answers. It is not going to profit anybody to spend enormous sums of money trying to filter out something that passes right through the filter and still causes the difficulty. But, given time, we will find the right answer.

MARKET OUTLOOK FOR PROTEIN AND OIL

By Harold L. Wilcke[1]

Please note that the title of this talk has just been changed to "Look Out for the Markets." The people who really know this field, the experts, tell me that never in their experience have there been so many uncertainties, so many confusing factors, affecting the supply and, to a lesser extent, the demand for oilseed protein, resulting in the most volatile market we have ever had. Perhaps the only reasonable way to describe the outlook for the next 6 to 8 months is that it will be erratic, interesting, exciting, and confusing, and that there will be a much larger than usual quota of ulcers among people who are involved in those markets.

A review of some of the major factors affecting this situation may be helpful in understanding why the market is so unusual.

1. The world fishmeal shortage. This is a result of the failure of the fishing off the coast of Peru. In April 1972, water temperatures rose along the coast of Peru because of a layer of warm water flowing south from the Equator along Peru and Chile. This warm water replaced the cooler water of the Humboldt Current, which normally runs near the shore and is fed by waters from the Antarctic and which provides the normal feeding place for the species of fish common to that area. This is by far the worst "El Nino" there has been since 1925. The water temperatures have remained above normal and, consequently, there has been very little fishing in that area. Since Peru is by far the largest supplier of fishmeal in the world market, this failure has resulted in nonavailability of fishmeal for animal feeds, and animal feeders turn to oilseeds, particularly the soybean, as a replacement for the fishmeal in animal rations. Since fishmeal is higher in protein, this has resulted in a very sharp increase in the demand for oilseed meals. As a consequence also, the price of fishmeal has risen sharply, but the exact quotation of fishmeal on the market at the present time is largely academic because no supplies are available in quantity. This, then, has had a very marked effect on both the demand and price for oilseed proteins. Hope has been expressed by Peruvian officials that this situation will be corrected around March 1, 1973, but, of course, there is no certainty that this will occur.

2. Weather conditions throughout the major oilseed-producing areas of the United States, the U.S.S.R., and India. Extremely wet weather delayed spring planting of soybeans, but of much greater importance was the delay caused by the wet weather which continued through the fall months. This has delayed the harvesting of both soybeans and cotton. In fact, harvesting was delayed to the point where it had not yet been fully completed at the end of January. Muddy fields made it impossible to operate combines, the rain increased the moisture content of the soybeans where they had been dry at one time, and these delays made the harvesting so late that snow covered much of the crop, resulting in a much higher field loss than expected. Partly because of this, and probably partly because of an over-optimistic assessment of the yields for the year, the estimates of 1972 production of soybeans have been revised downward rather sharply over the past month. Failure in the monsoons in India and drought in parts of the U.S.S.R. have reduced yields in those countries as well.

3. Sales of soybeans and feed grains to the U.S.S.R. The sale of some 40 million bushels of soybeans, 275 million bushels of corn, and 400 million bushels of wheat to the U.S.S.R. did have an impact on the supply and the price of feed grains and soybeans. Further, there is uncertainty regarding the amounts that the U.S.S.R. may purchase during the coming year. About 75 million bushels of soybean sales are predicted by some. Even rumors of such sales have an ef-

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fect when the market is as volatile as it has been for the past several weeks.

4. Tight supply of urea. With the present prices of urea and of feed grains, it is attractive to the livestock feeder to substitute urea plus grain for oilseed meals. However, in a situation where there is some difficulty in obtaining sufficient supplies of urea, this use is limited and, of course, puts more pressure on the use of oilseed meals, resulting in greater demand than there would otherwise be. If one uses the values for corn and urea prevailing at Memphis on January 29 ($66 per ton for corn and $70 for urea), the standard substitution, on a nitrogen basis, would indicate a value of $66.50 per ton for cottonseed meal at Memphis on that date. When calculated against the urea plus wheat middlings substitutions, the value of 41% cottonseed meal would be approximately $77–$78. The values for the 44% soybean meal would be very little different. Of course, other values must be considered, such as phosphorus, energy, and some vitamin content, but these do not seem to change the values very much. This, then, leads to the logical question as to why there has been such a wide differential, amounting to as much as $45 per ton, between 41% cottonseed meal and 44% soybean meal at Memphis on a given date. First of all, the substitution of either urea and corn or urea and wheat middlings or urea and grain sorghums for an equivalent level of nitrogen from cottonseed meal is effective only in ruminants. Since one of the major markets for cottonseed meal and cake has been to the beef cattle industry, the competition from the lower priced substitution has been felt more in the cottonseed meal market than it has in soybeans. This is partly because the cottonseed industry has traditionally had a larger share of the beef cattle market, particularly the range cattle market, and partly because soybean meal moves freely into nonruminant rations, specifically for poultry and swine. Therefore, the brunt of the economics of the use of urea has not been as noticeable in the soybean meal picture as it has in the cottonseed meal. Second, increased freight rates have curtailed the movement of cottonseed meal into some of the large animal-feeding areas. In other words, a greater differential between soybean meal and cottonseed meal is required before cottonseed meal can replace the soybean meal economically in livestock rations at points outside the cotton-producing areas. It is also interesting to note that the national feed manufacturers are the first to move when the economics of substituting cottonseed meal for soybean meal in nonruminant rations is favorable for use of the cottonseed meal in ruminant rations outside the cotton-producing belt. This is followed by the regional feed manufacturers, and many of the local manufacturers never recognize the advantage or their volume is too low to make it profitable for them to ship cottonseed meals for great distances. This higher cost of shipping, coupled with the limited supply of cottonseed meal, has resulted in some reluctance on the part of feed manufacturers to move rapidly when advantageous price spreads do occur, because of relatively small increase in usage results in either lack of supply or a decrease in differential which makes it unprofitable to substitute the cottonseed meal for soybean meal in out-of-position locations. Third, in spite of efforts of the National Cottonseed Products Association to disseminate correct information on the energy value of cottonseed meals, many feed manufacturers use lower-than-justified values for energy in cottonseed meals. Part of this, I'm sure, is because of the higher hull content in the lower protein cottonseed meals that are offered on the market. It is quite certain, though, that these wide differentials will not continue, and that a more normal differential will exist in the markets as supplies become less erratic.

The foregoing discussion has applied almost wholly to the use of vegetable proteins for animal feeding. In contrast, the market for the oilseed protein products to be consumed directly by humans is very calm and placid. Figures for the consumption of oilseed proteins in the really large consuming areas, that is, the Far East, are not available to me. However, it has been estimated that, in 1969, 64.1 million pounds of flour and grits was consumed for human food in the United States and that 23.1 million pounds of concentrates and 36.1 million pounds of isolates were used in human foods. The concentrates, of course, are defined as those products having approximately 70% protein equivalent, and isolates are those that are over 90% protein equivalent. When we translate this into the soybeans necessary to produce these amounts, we arrive at 95.6 million pounds of soybeans used to produce flour and grits, 46.2 million pounds to produce concentrates, and 144.4 million pounds of

the soybeans to produce the isolates. This is a total of 286.2 million pounds of soybeans going into the process of producing edible protein products. The amounts of other oilseed products, that is, the protein fraction, going into human consumption is negligible, and we do not have figures for the amount of cottonseed protein going into edible products. On a percentage basis, then, only about 0.3 to 0.4 of 1% of the protein from soybean production goes into direct human consumption. This would be significant only in times of extremely tight supplies. Of course, this also leaves room for a great deal of increase in the use of the oilseed proteins for direct human consumption.

Since the marketing of oilseed products, including both protein and oil, is becoming a more truly worldwide trading practice, the worldwide statistics of production and consumption become much more important in interpreting U.S. trends and markets. Table 1 shows that not only are soybeans by far the leading major oilseed, but that this is the only crop that has shown a consistent increase year after year in the periods that we have studied here. Worldwide production of cottonseed slumped somewhat in 1969 and 1970 after a large crop in 1968 and then again showed an increase in 1971. There was very little increase in the production of peanuts or sunflowerseed over the 5-year period, but rapeseed showed some signs of increasing in 1970 and 1971.

In order to get some idea of who the major competition is for the various crops, we have listed the principal producing countries for each of the major oilseeds. In table 2, we have cottonseed production. It is apparent that the U.S.S.R. is the leading cotton-producing country. I think

TABLE 1.—*World oilseed production (major crops), 1967–71*[1]

[1,000 metric tons]

Commodity	1967	1968	1969	1970	1971
Cottonseed	19,846	21,978	21,275	20,858	22,536
Peanuts	17,258	15,467	16,685	17,328	18,143
Soybeans	36,350	39,643	40,361	41,567	43,631
Sunflowerseed	9,470	9,373	9,450	9,385	9,385
Rapeseed	5,043	5,438	4,742	6,396	7,688
Total	87,967	91,899	92,513	95,534	101,383

[1] From Foreign Agriculture Circular FFO 2-72, U.S. Department of Agriculture.

TABLE 2.—*Cottonseed production by country, 1967–71*[1]

[1,000 metric tons]

Country	1967	1968	1969	1970	1971
U.S.S.R.	3,755	3,755	3,600	4,365	4,485
United States	2,912	4,209	3,690	3,713	3,974
China, mainland	2,960	2,875	2,875	2,915	2,915
India	2,312	2,138	2,225	1,920	2,182
Brazil	1,193	1,458	1,370	994	1,392
Pakistan	1,056	1,073	1,093	1,071	1,171

[1] From Foreign Agriculture Circular FFO 2-72, U.S. Department of Agriculture.

it is fair to assume that the motivating force for the increases in its production is primarily the need for fiber, with secondary emphasis on oil. The production areas, again, are out of position for the use of the protein in livestock feeding. With the exception of the U.S.S.R., the production of cottonseed has been quite stable in most of the larger producing areas.

Table 3 shows quite a different picture for the production of soybeans. Here the United States is by far the leading producer, with 73% to 75% of the total world crop. However, the increases in production in this country have been relatively small the last few years, and it seems that Brazil is increasing production faster than any other country. Brazil is expected to become a major factor in the production of soybeans soon. Of course, if present trends continue, this increased production is going to be needed to meet world demand. Intentions for next year's crop will not be known for another month or so, but there are some factors which will limit response. First, because of the almost disastrous harvesting season this fall, there is a question whether there will be sufficient good seed available. When high-quality seed is not available and inferior seed is used, the result will be poorer stands and lower production. If this prediction of the lack of avail-

TABLE 3.—*Soybean production by country, 1967–71*[1]

[1,000 metric tons]

Country	1967	1968	1969	1970	1971
United States	26,564	30,022	30,653	30,583	31,825
China, mainland	6,950	6,480	6,200	6,900	6,900
Brazil	716	654	1,057	1,332	2,100

[1] From Foreign Agriculture Circular FFO 2-72, U.S. Department of Agriculture.

ability of high-quality seed is realized, increases in acreage will not yield a proportionate increase in total production. Second, there is some thought that there may be a shortage of fertilizer during the coming spring, caused by very low usage during the fall, and exports to higher priced markets during the price ceiling period. Because of the wet weather, farmers were not able to do very much fall plowing; and, consequently, very little fertilizer was plowed down in the fall months. The diversion to fertilizer production seems to be one of the reasons for the tight urea supply at the present time. Third, I personally have a very serious question as to whether much of the land that is out of production would be suitable for soybean production even if it is returned to cultivation. Therefore, while it is quite certain that there will be an increase in soybean production in the United States next year, we would not expect that we will be deluged with bean next fall.

The production of peanuts (table 4) seems to have been quite stable in the six leading peanut-producing countries from 1967 to 1971.

It will be noted in table 5 that the United States is not listed as one of the major producers of sunflowerseed. The U.S.S.R. is by far the largest producer, but it is interesting to note that this past year the United States exported some $25 million worth of sunflowerseed products.

The production of rapeseed (table 6) has increased very considerably in Canada. Thus, Canada has replaced India as the major rapeseed-producing country. Part of this is due to the fact that Canada has found a means of inactivating the toxic principle in rapeseed, erucic acid, and more recently has made considerable progress in reducing or eliminating this fraction from the rapeseed by genetic means.

TABLE 4.—*Peanut production by country, 1967–71*[1]

[1,000 metric tons]

Country	1967	1968	1969	1970	1971
India	5,731	4,631	5,130	6,065	5,800
China, mainland	2,300	2,150	2,350	2,650	2,700
United States	1,122	1,153	1,147	1,351	1,357
Nigeria	1,260	1,445	1,360	775	1,000
Senegal	1,005	830	800	554	875
Brazil	751	754	754	928	800

[1] From Foreign Agriculture Circular FFO 2-72, U.S. Department of Agriculture.

TABLE 5.—*Sunflowerseed production by country, 1967–71*[1]

[1,000 metric tons]

Country	1967	1968	1969	1970	1971
U.S.S.R.	6,079	6,150	5,849	5,652	5,244
Romania	720	730	747	769	900
Argentina	1,120	940	876	1,140	830

[1] From Foreign Agriculture Circular FFO 2-72, U.S. Department of Agriculture.

TABLE 6.—*Rapeseed production by country, 1967–71*[1]

[1,000 metric tons]

Country	1967	1968	1969	1970	1971
Canada	560.2	440.0	757.5	1,637.5	2,234.0
India	1,228.0	1,567.7	1,347.0	1,563.6	1,962.9
China, mainland	800.0	786.0	688.0	780.0	830.0
France	432.5	357.3	512.5	567.1	621.0

[1] From Foreign Agriculture Circular FFO 2-72, U.S. Department of Agriculture.

Here in the United States, as shown in table 7, soybeans account for approximately 84% of the total production of the major oilseeds. This is in spite of a very substantial increase in the production of cottonseed in 1972 over 1971. Of course, the 1972 figures are estimates. The exports of soybeans are presented in table 8, by principal area of trade. Exports of cottonseed, for all practical purposes, are limited to the product that is to be used as seed itself, so that commodity is not included. About 90% of North American exports go to Canada, with Mexico taking a small amount. In South America, the principal country importing from the United States is Venezuela. In Europe, the principal ex-

TABLE 7.—*Total U.S. production of oilseeds (major crops), 1967–72*[1]

[1,000 metric tons]

Commodity	1967	1968	1969	1970	1971	1972
Soybeans	26,564	30,022	30,653	30,583	31,825	34,800
Cottonseed	2,912	4,209	3,690	3,713	3,974	5,001
Peanuts	1,122	1,153	1,147	1,351	1,357	1,495
Sunflowerseed	102	71	78	85	162	372
Total	30,700	35,455	35,568	35,732	37,318	41,668

[1] From Foreign Agriculture Circular FFO 2-72, U.S. Department of Agriculture.

TABLE 8.—*U.S. soybean exports, 1968–72*[1]
[1,000 metric tons]

Continent	1968	1969	1970	1971[2]	1972[2]
North America	1,055.1	2,055.4	1,222.7	942.8	784.0
South America	45.1	62.0	105.9	84.2	52.6
Europe	4,166.1	6,024.4	6,667.5	5,776.0	5,762.6
Asia	2,566.0	3,652.3	3,805.9	3,203.9	3,374.6
Total ..	7,822.5	11,800.0	11,815.4	10,020.6	9,973.8

[1] From Foreign Agriculture Circular FFO 20-72, U.S. Department of Agriculture.
[2] September–June only.

ports are to the Common Market countries, with Spain and Denmark also taking appreciable amounts. In Asia, Japan takes by far the greatest amount of soybeans, with Taiwan second. The figures that are available do not cover the recent exports to the U.S.S.R. Since the U.S.S.R. has reportedly purchased machinery to construct at least four processing plants, it will no doubt continue to import soybeans. The most recent projections are that our exports of soybeans during this crop year will be more than doubled.

U.S. exports of oilseed cakes and meals are given in table 9. Our principal customer has been Europe, and there again, the Common Market has been by far the biggest customer.

In table 10, exports of soybean and cottonseed oils are combined. In North America, again, our biggest customer for oils has been Canada, with the Dominican Republic taking about half the amount that Canada did in 1972. In South America, Peru has been our biggest customer, but the amounts they have taken have been decreasing from 1970. The second largest customer is Uruguay. In Europe, the biggest customer has been Yugoslavia, with the U.K. second. In Africa, Algeria, Morocco, and Tunisia have been the leading importers, while in Asia, Pakistan, Indonesia, and Hong Kong have been the leading importers. As mentioned previously, India for this coming year is a question mark.

TABLE 9.—*U.S. exports of oilseed cakes and meals, 1968–72*[1]
[1,000 metric tons]

Commodity	1968	1969	1970	1971[2]	1972[2]
Soybeans:					
North America	257.4	271.8	380.7	270.9	234.9
South America		2.7	11.7	9.9	19.8
Europe	1,200.0	1,595.0	1,786.4	1,304.5	1,144.1
Asia	81.9	162.9	136.8	94.5	105.3
Total	1,383.6	1,834.1	2,072.3	1,506.8	1,334.1
Cottonseed: Total	13.5	17.1	24.3	24.3	5.4

[1] From Foreign Agriculture Circular FFO 20-72, U.S. Department of Agriculture.
[2] September–June only.

It is interesting to note that 82% of our oil exports in 1967 were under Public Law 480, while that amount decreased to 40% in 1971. While a free substitution is permitted between soybean and cottonseed oils under Public Law 480 sales, practically all sales under that law have been in soybean oil because of the slightly lower price. Simply put, countries importing from this country can get more pounds of soybean oil for the same amount of money. This is not true in Egypt, where the exports from this country have been largely cottonseed oil under Commodity Credit Corporation loans. Very clearly, then, the competitor of cottonseed oil for

TABLE 10.—*U.S. exports of soybean and cottonseed oils, 1968–72*[1]
[1,000 metric tons]

Continent	1968	1969	1970	1971[2]	1972[2]
N. America	52,516.8	100,731.8	83,854.0	66,550.9	52,132.7
S. America	64,505.9	83,405.9	128,088.6	94,226.8	60,678.6
Europe	18,441.8	100,714.5	218,324.5	191,376.3	125,956.8
Africa	56,569.0	134,925.9	135,871.3	104,827.2	163,375.4
Asia	265,295.4	427,319.0	388,611.3	252,156.8	268,320.0
Total	458,497.7	851,095.4	960,706.8	714,384.5	671,615.0

[1] From Foreign Agriculture Circular FFO 20-72, U.S. Department of Agriculture.
[2] October–June only.

the export market in edible oils is soybean oil. The estimates for exports, however, do show a decided increase in the export of cottonseed oil, about 405,000 metric tons in 1972, considerably above 1971 exports.

Now, when we look at the importation of edible oils into this country (table 11), coconut oil and palm oil are the two major imported oils. There was a decided drop in the importation of palm oil during 1970, but this was largely because of lack of availability from the producing countries, primarily Malaysia, Indonesia, and countries in Africa. In terms of edible oils, the only area that we are in deficit trading position with is East Asia and the Pacific islands, from which we import many times more oils than we export. The United States is the largest exporter of edible oils, followed by East Asia and the Pacific islands and by the East and West African countries. Therefore, it would seem that our major customers are in Europe, North Africa, West Asia, and Japan. The question of exports to the U.S.S.R., Hungary, and other Communist bloc countries has, of course, been considered as a possible factor, but the total volume of trade to those countries has been very small compared with these other markets. Palm oil appears to be the most rapidly increasing oil from the exporting countries. It is expected that the plantings in Malaysia and Indonesia will probably yield additional increases in the supply of palm oil, as will the plantings from the Ivory Coast, which we may expect to come into production in the next few years. Nigeria and the Congo are increasing their oil consumption and are not expected to increase their exports of palm oils materially.

In summary:

1. It is anticipated that the markets for oilseed protein meals will be chaotic during the next 6 to 8 months. The one factor most likely to stabilize the market would be resumption of fishing off Peru.

2. It was expected that the U.S.S.R. would continue their purchases of both oilseeds and feed grains, but after recent developments which returned the emphasis to industrial rather than consumer goods, the prospects are even more uncertain. The use of oilseed meals for the protein for animal feeding in the U.S.S.R. has been below what we think are efficient feeding standards. It has been estimated that feeding practices there in 1960 utilized only about 25% of what we considered to be the requirement for optimum animal nutrition, which has now been increased to 37% or 38% because of emphasis on better feeding practices. Therefore, because of the previous commitment to provide more meat for its people and because of the return to emphasis on industrial production, we may expect that there will be greater demand for oilseed protein for animal feeding purposes from the U.S.S.R. now that shipments have been started.

3. Our biggest customers for exported oilseed oils have been to the Common Market, other Western European countries, Japan, and parts of Africa. We may expect that there will be greater trade with some of the Communist bloc countries. The question of how rapidly this will develop is, of course, not known at the present time.

4. While there has been an increase in importation of palm oil into this country, we are exporting considerably more cottonseed oil than we are importing palm oil.

5. With the resumption of trade with Communist bloc countries, the world market will have a more pronounced impact on our domestic planning and marketing.

6. The present high prices of meats, vegetables, and fruits will undoubtedly increase the opportunities for direct consumption of oilseed proteins in this country. The question will be whether the industry can respond rapidly enough to take advantage of this opportunity.

7. The consumption of oils and fats in the developed countries, including the United States, has been underestimated, and with a normal crush in this country, we can expect that our oil supplies will be utilized with very little change in price, in spite of bearish pressures on oil prices in the world market.

TABLE 11.—*U.S. imports of oils, 1969–71*[1]
[1,000 metric tons]

Oil	1969	1970	1971
Rapeseed	4.3	3.3	5.0
Palm kernel	45.0	37.0	43.0
Palm	72.0	64.0	103.0
Olive	26.2	28.3	28.0
Coconut	194.0	270.0	285.0
Total	341.5	402.6	464.0

[1] From Foreign Agriculture Circular FFO 20-72, U.S. Department of Agriculture.

THE PRODUCTION OF EDIBLE FLOUR FROM COTTONSEED BY THE MODIFIED LIQUID CYCLONE PROCESS

By Homer K. Gardner, Jr.,[1] Robert J. Hron, Sr.,[1] Henry L. E. Vix,[1] and Jim M. Ridlehuber[2]
(Presented by Homer K. Gardner, Jr.)

INTRODUCTION

The last time I presented a report to this clinic on the liquid cyclone process (LCP), little did I know that it would intensify interest in its commercialization. The first series of LCP pilot-plant flour production runs had just been completed, and 1,700 pounds of edible flour had been produced from Mississippi Delta cottonseed. This flour analyzed as the best ever produced in quantity from glanded cottonseed, but the yield was low—33 % to 35 % of oil-free solids put into the process. As a result of the quality of the flour product, Grain Processing Corporation, Muscatine, Iowa, became interested in its potential and, at their request, several hundred pounds were sent to them for further evaluation. Evidently they liked what they saw in the flour. At about the same time, the Plains Cooperative Oil Mill, Lubbock, Tex., became more interested in the process as a means of extending their outlets for cottonseed products into the food market. Consequently, Plains Cooperative Oil Mill and Grain Processing Corporation joined together in an agreement to produce and market cottonseed flour for food uses.

Plains Cooperative Oil Mill was now interested in producing LCP flour. However, we still had to determine whether cottonseed kernels produced on the Texas High Plains would process like kernels from cottonseed produced in the Mississippi Delta. Some differences were noted.

After intensive research, modifications necessary for processing Texas-produced kernels were developed, and in doing so, the LCP was simplified. The modifications were as follows: (1) The moisture level of the kernels before comminution was reduced from 3 % to 1.5 % and (2) flaking followed by solvent milling in a stone mill was replaced by dry milling in a wide-chamber, sieveless, impact stud mill.

Approximately 6,500 pounds of flour from glanded cottonseed kernels produced on the

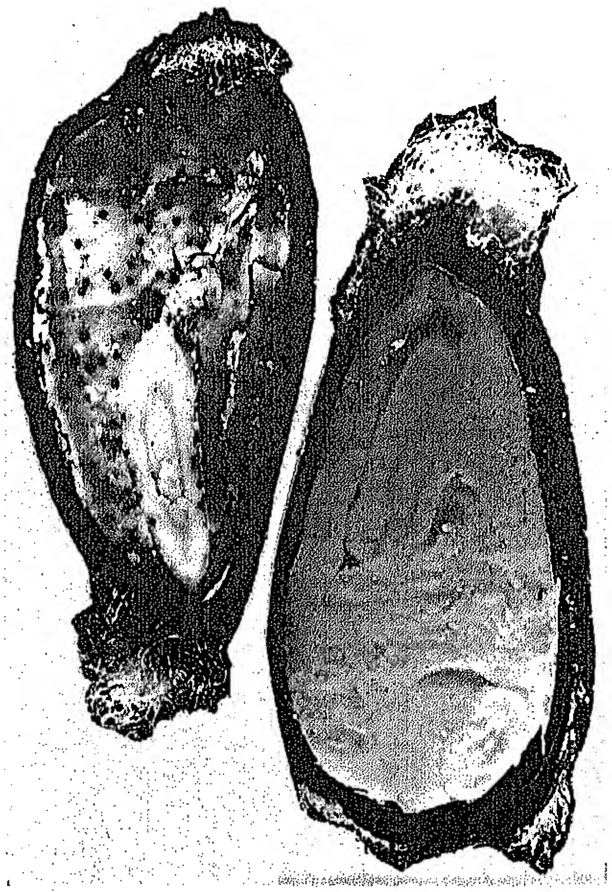

FIGURE 1.—Cross sections of a glanded and glandless cottonseed.

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Texas High Plains and 250 pounds of flour from glandless cottonseed from the same area have been produced by the modified liquid cyclone process. The yield of flour from oil-free solids put in to the process has been increased to about 45%.

As soon as the LCP was shown to be adaptable to cottonseed from both the Mississippi Delta and the Texas High Plains, a petition was filed in the fall of 1970 with the Food and Drug Administration, requesting approval of LCP cottonseed flour as a food additive. This approval was granted and appears in the Federal Register of July 13, 1972.

Figure 1 shows the cross sections of a glanded and glandless cottonseed. The glanded cottonseed on the left contains dark specks in the kernel. These are pigment glands, which contain about 40% gossypol by weight. The LCP removes these glands intact to produce a high-protein, low-gossypol flour. Glandless cottonseed, of course, presents even fewer problems to the LCP. With kernels from this seed, a high-protein cottonseed flour somewhat lighter in color can be produced and used for a food additive. In addition, the cyclone underflow product which has about 50% to 54% protein, can also be used as a food additive or as a starting material for cottonseed protein isolate production.

Figure 2 shows a scanning electron micrograph of a single pigment gland still embedded in and surrounded by cell tissue. The difference in the relative sizes of the pigment glands and spongy mesophyll cells makes it possible to separate them. The spongy mesophyll cells contain aleurone grains or protein bodies, spherosomes (lipid particles), globoids (phytin storage sites), and a nucleus. Figure 3, which shows cottonseed meat tissue and pigment glands in hexane, illustrates the integrity of the glands.

Figure 4 shows the liquid cyclone process flowsheet for the removal of pigment glands and the production of a high-protein, low-gossypol flour from glanded cottonseed. The LCP utilizes whole and cracked meats, essentially hull-free, obtained from prime-quality cottonseed uncontaminated with salmonella or aflatoxins. The kernels shown on the flowsheet contain less than 1% hulls.

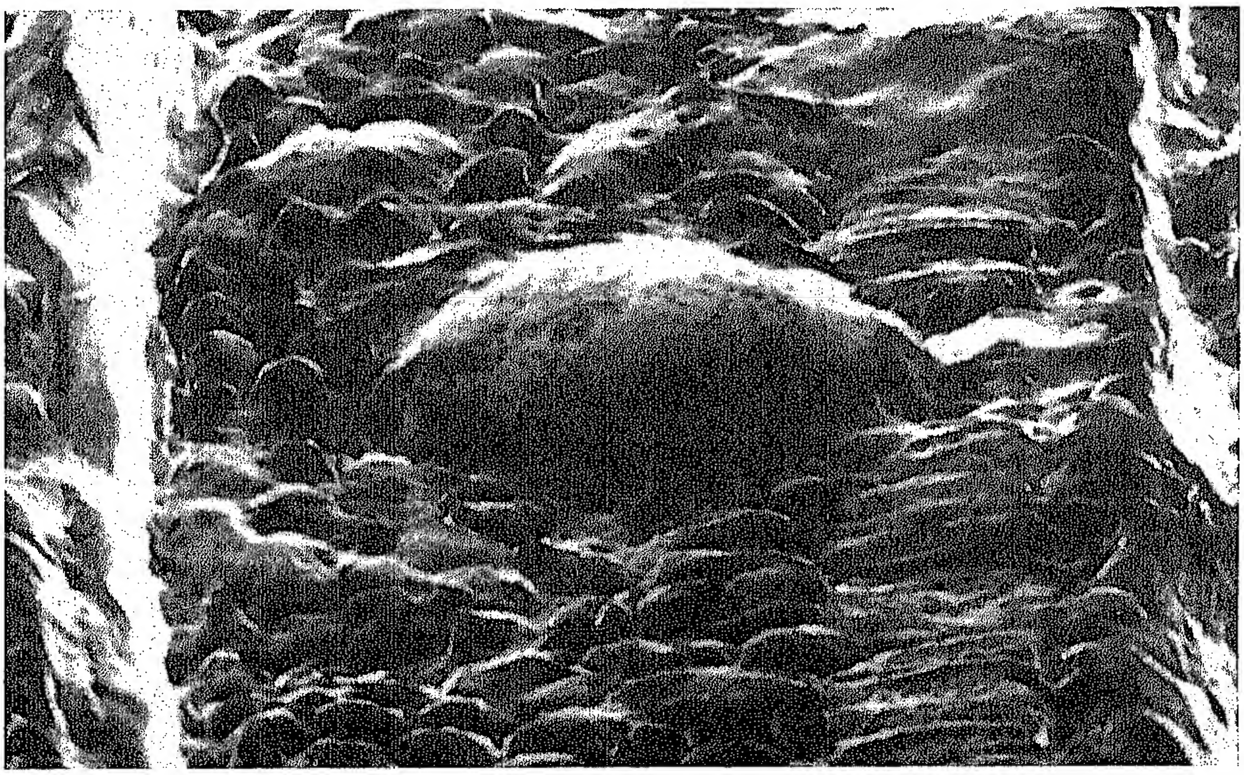

FIGURE 2.—Scanning electron photomicrograph of a single pigment gland still embedded in and surrounded by cell tissue.

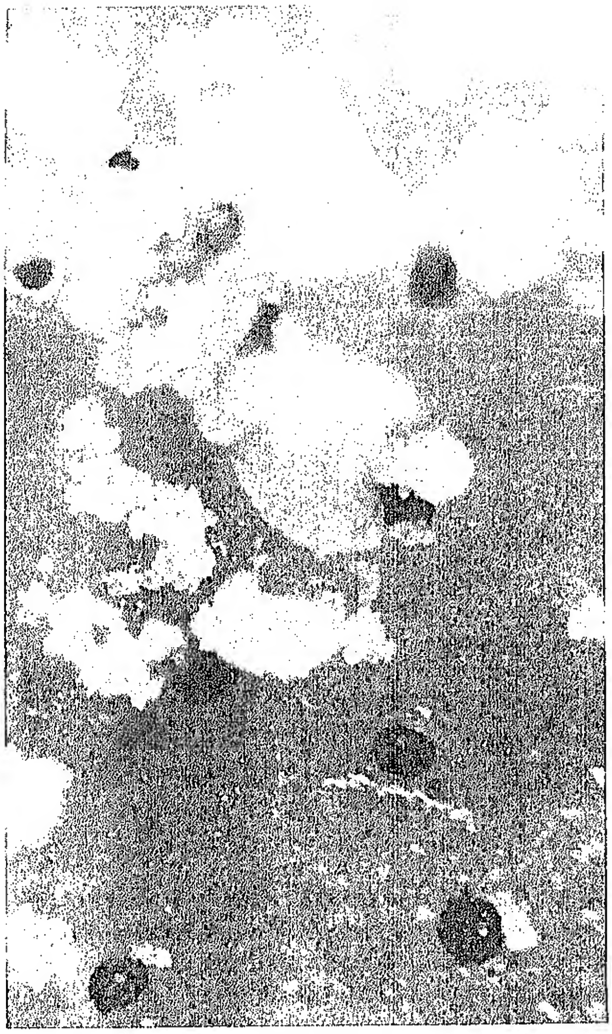

FIGURE 3.—Cottonseed meat tissue and pigment glands in hexane.

DRYING

The first operation is drying of the kernels (fig. 5). The purpose of drying is (1) to remove water because it is an excellent solvent for rupturing the pigment glands, (2) to toughen the pigment glands, and (3) to make the proteinaceous material more friable. The latter two are very important in the comminution, or milling, of the dried kernels.

The stainless-steel, belt-type dryer has a drying area of 30 ft^2 with 42% open area in the belt. With a 3-inch bed depth, a 65-min rentention time, and a 180°-F air temperature at a velocity of 70-80 ft/min, 270 lb of kernels per hour can be dried from 6.3% moisture content to 1.5%. At this air temperature, the protein quality of the kernels is essentially unaffected.

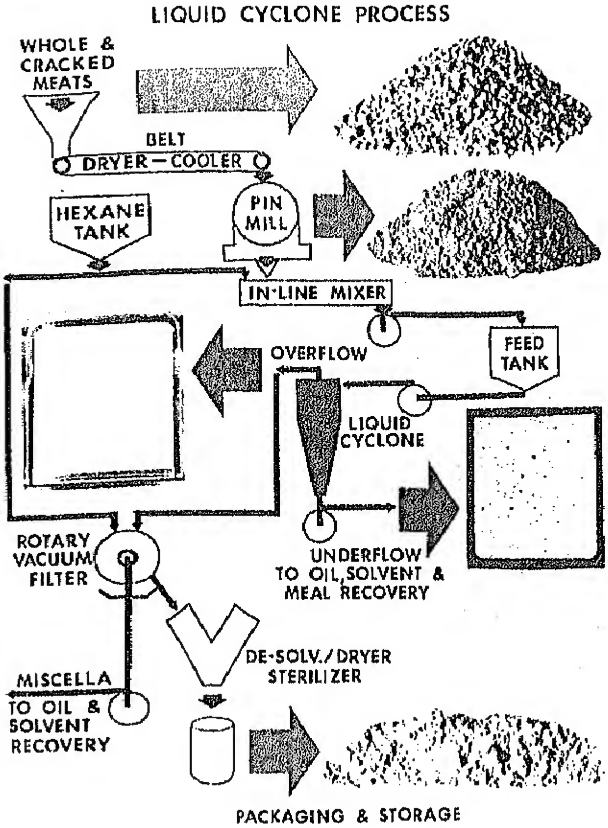

FIGURE 4.—Pilot-plant liquid cyclone process flowsheet.

Although it is not included in our pilot plant, a kernel cooling step is necessary between drying and comminuting in a continuous operation.

COMMINUTION

Comminution of the cottonseed kernels is one of the most important steps in the process. Without adequate comminution the yield of flour will be low; with too much or severe comminution the pigment glands will be ruptured.

The comminuting equipment unit, a sieveless, wide-chamber Alpine American Contraplex (fig. 6), simplifies the process and makes possible the comminution of Texas High Plains cottonseed kernels. This unit is one of the modifications of the original process.

The mill has two contrarotating disks with rings of intermeshing studs. The disks operate separately from the mill side and from the door at 9,500 to 2,500 r/min, respectively. Since the door disk pins are on the outer periphery when the door is closed and the pins intermesh, the centrifugal force on the full-fat flour being pro-

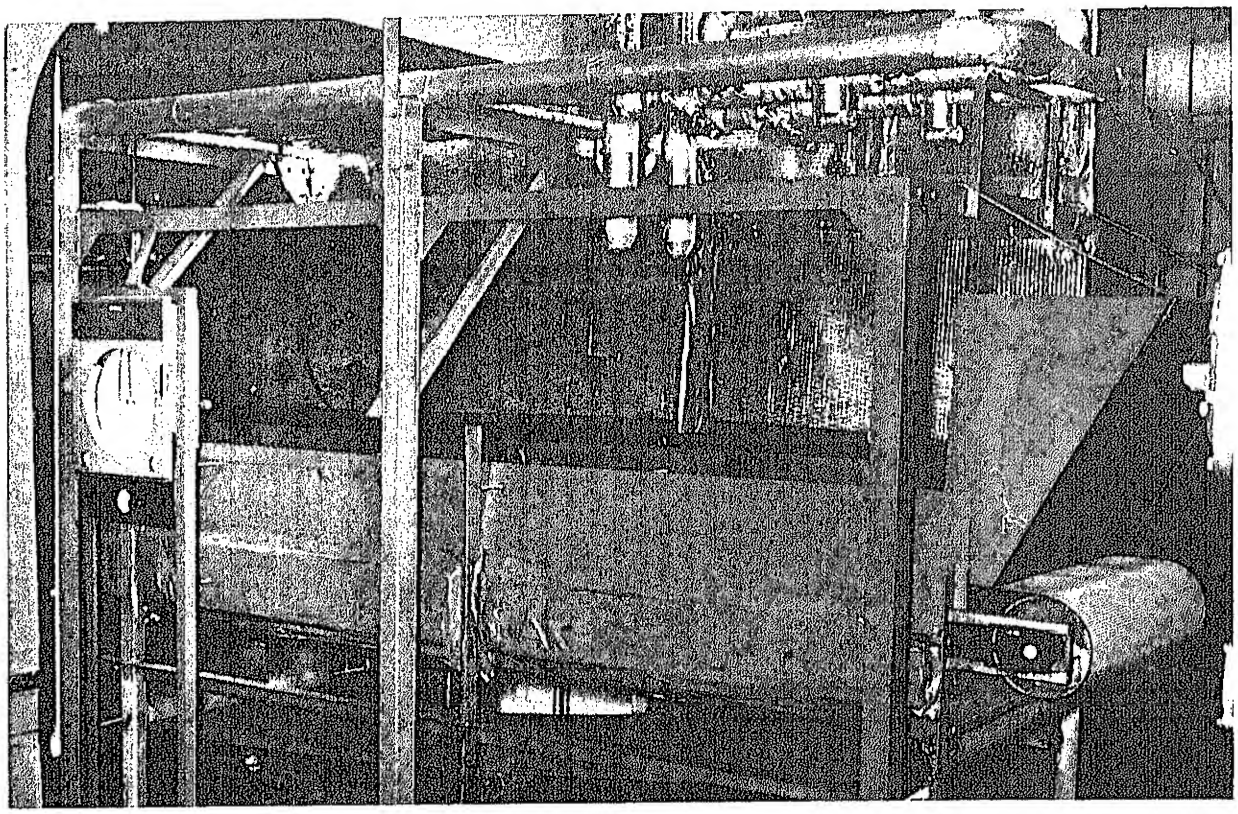

FIGURE 5.—Meats dryer.

duced is lessened. This reduction in force, along with the wide-chamber construction, minimizes buildup of flour on the walls of the mill. The mill is operated at a feed rate of 1,400 lb/h.

Frictional heat imparted to the flour is minimal because of the large amount of air generated during milling. With a temperature of 85° F for kernels being fed, the temperature of the milled material will not rise above about 124° F. This temperature is reached shortly after milling is begun, and no significant increases have been noted after extended runs of 1½ h. The air used by the mill should be dry and filtered.

Although we have stressed the necessity of using hull-free meats, the liquid cyclone can remove as much as 3 % hulls. Milling the hulls not only requires considerable power, but, most importantly, causes some gland rupture, which we certainly want to minimize.

IN-LINE SLURRY MIXING

In continuous operations the milled meats d go directly to an in-line slurry mixer. The plant mixer is a covered trough equipped paddles mounted at a 45° angle on a 120-r/min rotating shaft (fig. 7). The milled kernels are continuously metered into the trough along with hexane to produce a 40 % solids slurry. The dwell time in our in-line slurry mixer is about 7 min. In the pilot-plant installation, additional hexane is metered to the 40 % solids slurry as it enters the agitated cyclone slurry feed tank to produce a continuous 22 % solids feed for the liquid cyclone.

LIQUID CLASSIFICATION

The heart of the process is the liquid cyclone (fig. 8). Although it is only 3 inches in diameter and 10 inches high, the stainless-steel liquid cyclone can produce about 12 tons of flour per day. The cyclone is fed a 22 % solids slurry under an optimum pressure of 40 lb/in²g. The feed is separated or split by the cyclone into a gland-free overflow slurry containing 13 % to 15 % high-protein solids and a high-gossypol coarse meal underflow slurry containing 43 %-45 % solids. On a weight basis, the overflow accounts for about 70 % of the feed slurry. The cyclone split is controlled by adjusting the speed of the underflow slurry take-away pump. In adjusting the

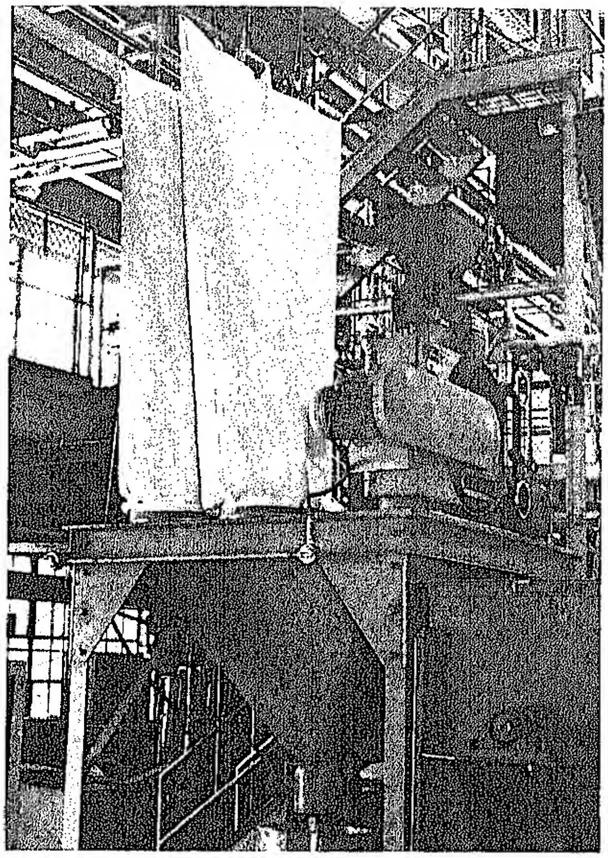

FIGURE 6.—Wide-chamber, impact stud mill

split, visual observation of the underflow slurry is most important. Experience has shown that when the optimum split has been achieved, the underflow slurry visible in the sight glass has a slow, laminar flow as it leaves the cyclone. Turbulence, which is indicative of disruption of classification within the cyclone, causes pigment glands to appear in the overs fraction. This condition calls for immediate readjustment of the split control, but can be avoided by maintaining control of the feed slurry solids. After the desired split has been attained, the overs-unders fractions are directed to their respective solids recovery operations. In the commercial installation an additional cyclone will be used to recover entrained fine flour from the unders fraction.

FILTRATION

Cottonseed flour from the overflow slurry is recovered by a totally enclosed, rotary, vacuum, drum-type filter with 9.4 ft^3 of surface area covered by a nylon cloth (fig. 9). Thirty-three percent of the filter surface is submerged. Cake one-eighth inch thick is accumulated on the submerged drum under vaccum (20 inHg). At 3.5 minutes per revolution and 13 % to 15 % solids in the feed slurry, 50 lb of 65 % solids cake can be produced each hour. After one hexane displace-

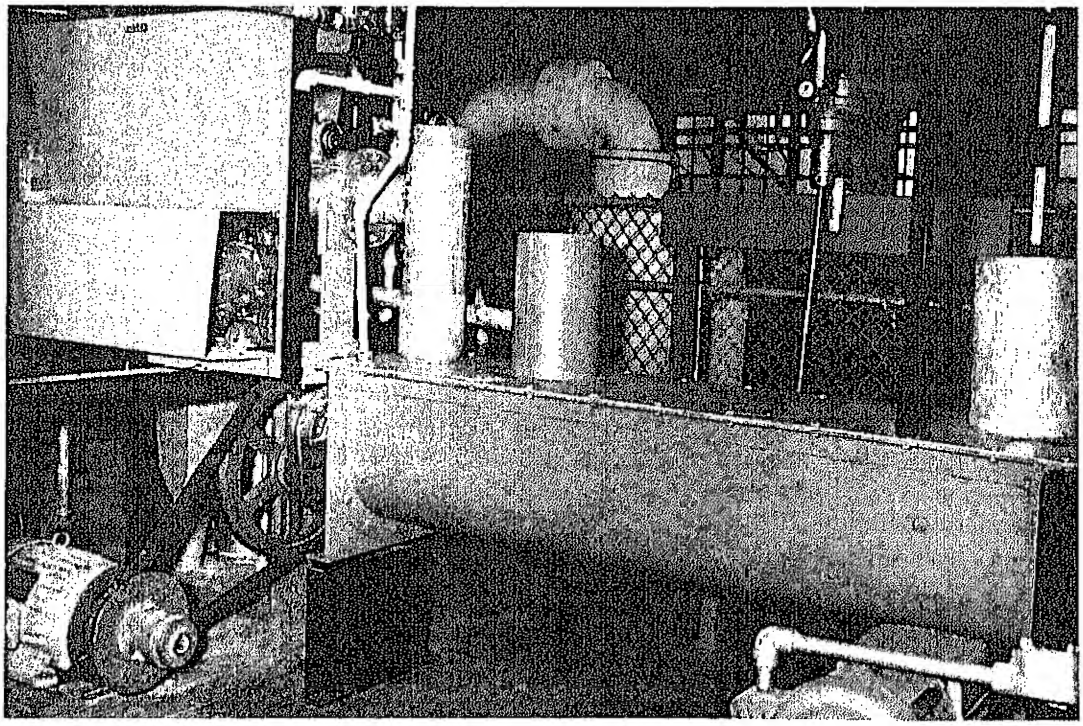

FIGURE 7.—In-line slurry mixer.

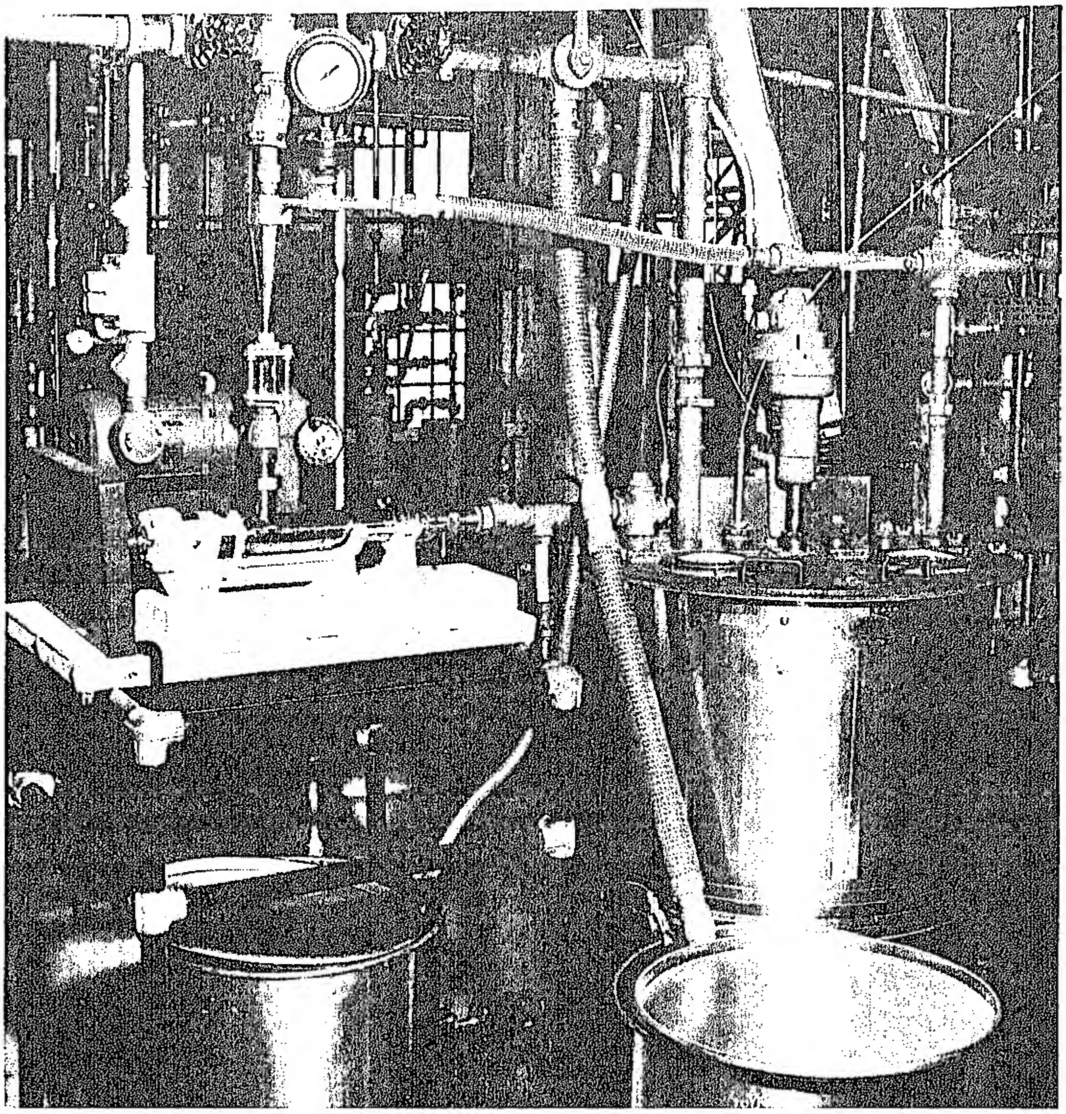

FIGURE 8.—Liquid cyclone and auxiliaries.

ment wash, the lipids in the cake average 0.60% on a dry basis. Early laboratory tests indicated that the filter cake readily cracked if not kept wet with solvent or miscella. This problem was also experienced in the pilot plant. However, the problem was solved by uniformly distributing a portion of the feed slurry on the cake as it emerges from the slurry trough and also maintaining a uniformly distributed solvent wash on the cake at the top of the rotating filter drum. At present, a solvent to cake ratio of 1.75 to 1.0 is being used.

The cake is removed from the filter drum by a combination of nitrogen gas blowback and a doctor blade. The recovered cake is stored in sealed drums for later desolventization.

In the commercial operation, the underflow slurry fraction will be recovered on a horizontal, rotary, vacuum, pan-type filter. The miscellas from both filtering operations will be combined and further processed.

DESOLVENTIZATION

Desolventization of the filter cake is carried out in a 30-ft^3, stainless-steel, jacketed, twin-shell blender equipped for vacuum and solvent recovery operations (fig. 10). The blender is charged with 500 to 800 lb of filter cake contain-

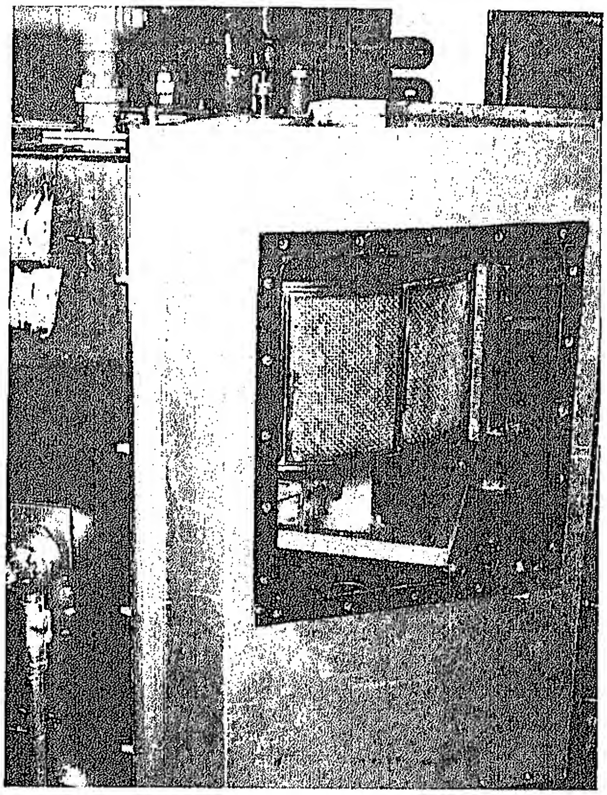

FIGURE 9.—Rotary, vacuum, drum-type filter.

ing about 35 % solvent. Operating conditions are 3 to 5 lb/in²g steam pressure in the jacket, and 24 inHg vacuum. When the temperature of the flour reaches 180° F, a nitrogen gas purge is initiated to strip solvent from the flour to a level below 50 parts per million. During stripping, the temperature of the flour is allowed to rise over the next 1½ h to 200° F to obtain maximum bacteria kill. Because of the absence of moisture in the flour, this increase in temperature has little to no effect on protein quality or flour color. The flour is then cooled to 110° F by introducing water into the jacket and then collected in drums with double polyethylene bag liners under conditions as asceptic as possible in the pilot plant. In the commercial installation, continuous desolventization will be carried out in a vapor desolventizer and vacuum deodorizer.

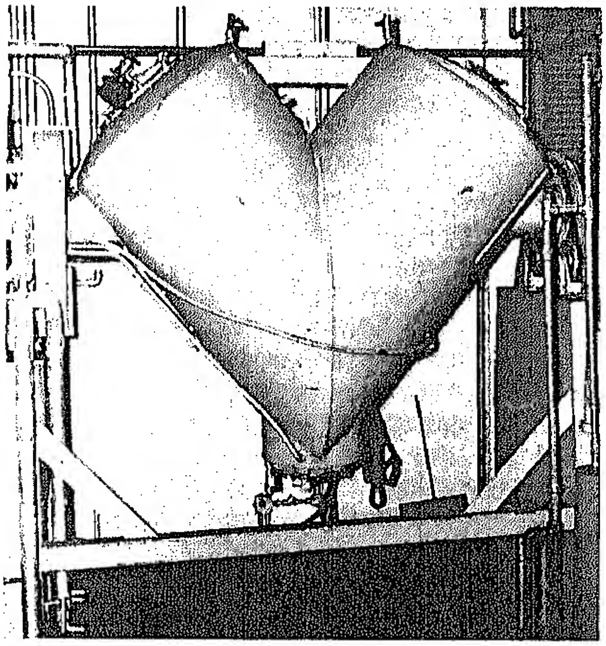

FIGURE 10.—Jacketed, twin-shell, blender desolventizer.

EVALUATION OF LIQUID CYCLONE PROCESS COTTONSEED FLOUR

By Robert L. Olson[1]

Liquid cyclone process (LCP) cottonseed flour as described in the previous paper has been extensively evaluated in a wide variety of food products. To be acceptable as a food ingredient, it must possess desirable functional and nutritional properties. The protein content of the flour runs about 65% to 67%. On a moisture-free basis, the protein content approaches 70%. The nutritional quality has been excellent. Protein efficiency ratios (PER), determined in our laboratory for five lots of cottonseed flour, varied from 2.51 to 2.67. These values compare to the standard of sodium caseinate, which has a PER of 2.50.

The color of the flour has been a cream white. An off-color has been imparted to some food products. This factor depends on the concentration of flour utilized and the pH of the food product. Some variations in product color will be noted later in the discussion.

Water absorption has been measured for several lots of flour. In these tests, the product commonly absorbed 2½ times its weight of water. Soy concentrates have absorbed about 5 times their weight of water and soy isolates 5 to 6 times their weight of water. The lower water absorption offers an advantage for cottonseed flour in some applications. However, in application areas where soy is utilized a simple substitution with cottonseed flour cannot always be made.

Oil absorption values of 1.5 times the sample weight have been obtained. Oil absorption values of 1.0 to 1.5 times sample weight were obtained for soy concentrates, and a value of about 1.5 for soy isolates.

The oil emulsification values of several lots were determined. Determinations generally ranged from 245 to 260 ml of oil per gram of flour. Various soy isolates will have values ranging from 100 to over 300. Different soy concentrates vary from less than 100 to 250 ml/g. It must be pointed out that these functional tests are not perfect nor are they standard industry procedures. The need for standardized functional tests was noted at the recent Conference on Oilseed Proteins. Care should be taken in making comparisons where methods differ. The tests do give some indication of relative differences in functionality to assist the food processor in devising formulations.

Several applicaton areas have been evaluated. In laboratory and plant trials the flour has been successfully utilized in several meat products. A considerable volume of beef patties is produced with added soy concentrate and nonfat dry milk (NFDM). Cottonseed flour has been used at levels of up to 8% in beef patties for the replacemen of soy and NFDM. Frying losses were reduced and a very desirable flavor and texture were developed.

In meatball and gravy and in chili preparations the separation of fat and moisture was retarded by the presence of cottonseed flour. Soy isolate and soy concentrate also aided in this capacity. Through proper formulation, cottonseed flour was as desirable as the soy products. The color and flavor of the samples containing cottonseed flour were excellent. The flour has been utilized in beef broth to replace a portion of the meat scraps and the starch. Through proper processing, small flakes resembling meat scraps were formed. The color was improved over broth made with starch. The broth did not have the undesirable shiny appearance which was characteristic of the product made with starch. The flour has been utilized in fresh sausage to aid in fat and moisture retention.

The cottonseed flour has been utilized in frankfurter products. At the present time, levels

od scientist, Grain Processing Corp., Muscatine, [illegible]1.

of 2% soy isolate or 3½% soy concentrate are permitted in frankfurters. In simple replacement tests the cottonseed flour has not performed as well as the soy products. This is partially due to a lower water absorption. The fat has not been retained as well by the cottonseed flour. Because of the lower water absorption, cottonseed flour may be a valuable ingredient for a high-protein frankfurter. The utilization levels of the soy products are limited by their high water absorption capacities. It is not possible to use some soy products at a 10% level. Cottonseed flour can be incorporated at this high level.

We have done a limited amount of work with extruded cottonseed flour. Initial results indicate promise for the use of the extruded material in meat products and cereals. Cottonseed flour has excellent expansion characteristics. Mixtures of wheat flour and cottonseed flour have produced very desirable cereal products.

The flour has been successfully used as a protein source in frozen desserts. A color similar to that of maple nut ice cream was imparted to this product. Several flavors can be prepared when utilizing cottonseed flour.

The flour has been evaluated in several baked goods. Thirteen percent of the flour in doughnuts was replaced with cottonseed flour, which imparted a very desirable yellow color. A slight darkening of crumb color was common when utilizing the flour in white bread. Generally, all other attributes received excellent ratings when cottonseed flour was used at a 3% (flour basis) level.

Cottonseed flour has been a very desirable ingredient in devil's food cake. Good color, flavor, grain, and texture were noted, and the cake had a more desirable moist sensation in the mouth than did control cakes.

Workers at Texas Technological University have evaluated several cookie formulations with added cottonseed flour. Several successful products were prepared in which 15% to 20% of the wheat flour was replaced with cottonseed flour. Several formulations were devised with even higher levels of cottonseed flour.

The flour imparted an undesirable greenish color to waffles and pancakes and a gray color to white layer cake.

We have evaluated the flour as a raw material for the preparation of protein isolates. Considerable work has been done at the Southern Regional Research Center (Agricultural Research Service) and reported at previous conferences. We have made some modifications in the process. We obtain a major and a minor protein isolate fraction. An additional processing procedure devised by Southern Regional Research Center workers results in a single isolate that is a combination of the major and minor protein fractions.

The major isolate has a white color. It is almost completely soluble at pH 3.5 and is dried at pH 3.5. It has been utilized in acidic beverages for protein fortification. The major isolate also is an excellent whipping agent. It compares very favorably with egg-white solids and sodium caseinate. It also compares favorably to special soy whipping agents which are commercially available. Of course, the pH of the food system will govern the choice of whipping agents. The major protein isolate will be useful in acidic systems. The minor isolate has a brown color. It is partially soluble at a neutral pH. When commercial production of the cottonseed flour commences this summer, the cottonseed protein isolates will be evaluated more thoroughly.

In summary, cottonseed flour has been successfully utilized in several food applications. Its nutritional value is excellent. In some cases it may compete directly with soy concentrates. However, functional properties are different, thus allowing the food processor additional latitude in the preparation of nutritious food products. An acid-soluble protein isolate can be prepared from the flour. This will be a protein ingredient desired by many food processors.

DEVELOPMENT OF A QUANTITATIVE DIRTS TEST FOR COTTON LINTERS

By John W. Smith,[1] G. N. Ferguson,[2] and J. D. Mills[3]
(Presented by John W. Smith)

Procedures have been available for a number of years for the estimation of the dirts content of linters or paper samples, but all of these involve subjective estimation by an operator. A procedure of this type was presented to the American Oil Chemists' Society by Jurbergs and Dowling about 9 years ago and was also published.[4] In that work a portion of the AOCS Official Cellulose Yield Cook residue was bleached and made into a handsheet, and dirts that were present were visually estimated. The objective of the current work was to develop a procedure that would eliminate the subjective aspect of the test and replace it with an instrument analysis.

Based on the amount of work that has been involved, it should be evident that Buckeye Corp. places considerable importance on the dirts level of the raw material, but I think it could be reasonably questioned as to why this is of such importance. The areas in which our finished products find application are quite critical of noncellulosic contaminants. This is true whether it is a paper in which dirts are esthetically undesirable or whether it is a dissolving pulp in which the impurities do not react in the same fashion as the bulk of the cellulose. As a consequence, considerable emphasis has been placed on those contaminants that survive the normal processes used in industrial cotton linter purification.

In seeking to develop an objective dirts test, several different approaches were considered. Among these were gravimetric procedures in which cellulose solvents were used to dissolve the cellulose leaving the impurities and dirts behind. These approaches gave some interesting results but were discarded because the cellulose solvents dissolved differing amounts of the various contaminants such as hull, stalk, or cocklebur.

By quantifying either the number or area of dirts in a standard sample, several approaches were available. The Pulp & Paper Research Institute of Canada has the Papric dirt counter, which determines the number of dirts in the surface of a sheet of paper. This approach has the disadvantage that no distinction is made between large dirts in the sheet and very small ones, because either is counted as one dirt. Several companies, such as Millipore, Leitz, and Imanco, have image analysis systems that make it possible to determine the area of dirts in a standard sheet as well as the number of dirts. Having surveyed the available equipment, it was decided to explore the Millipore PiMC image analysis system.[5] The preliminary checkout of the applicability of such a unit gave encouraging results, and it was decided to pursue the development of the test based on this equipment.

The PiMC system is essentially a computer analysis of the images of dirts. It utilizes a combination of closed-circuit television and a dedicated computer. The system can be used for microanalysis, but for our purposes in this testing the macro mode was used. This permitted the measurement of relatively large fields. The system is shown in figure 1. It consists of (1) a transistorized Vidicon television camera equipped with a 75-mm Bolex lens, (2) a camera con-

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[4] The Journal of the American Oil Chemists' Society [illegible]: 545–547.

[5] The cooperative assistance of Millipore in this work is gratefully acknowledged.

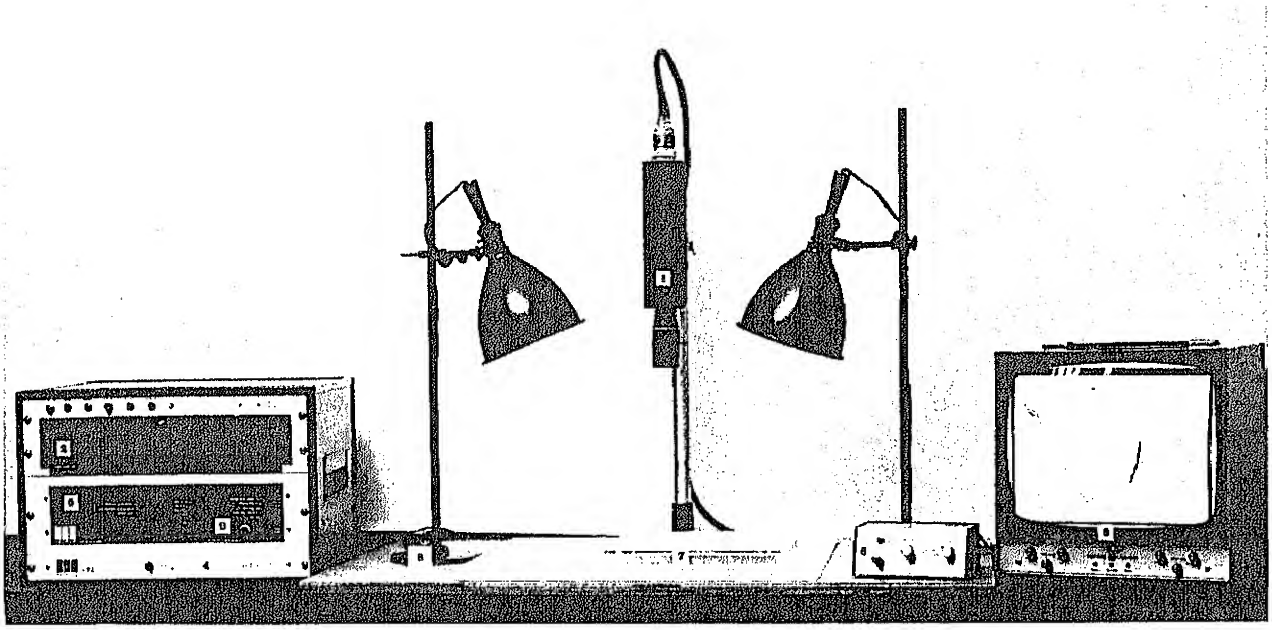

FIGURE 1.—Millipore PiMC image analysis system.

trol unit, (3) a television monitor, (4) the basic module, a dedicated computer, (5) a size measurement module, and (6) a control box. The mechanical stage (7) was fabricated by Buckeye, and the light table (8) was also assembled there. The decision to use reflected light was made after both transmitted and reflected light for the application had been considered.

The basic module (4) receives the signal from the camera and contains the sensing logic that identifies the presence of a particle in a field. The particle boundaries are defined within this module, and the information is processed into digital form. The size measurement module (5) contains the sizing logic and is used in conjunction with the entire field-of-measurement module (9). This combination of modules makes it possible to determine the area of particles in a single field or to determine the sum of areas in successive fields. It should be pointed out that the PiMC system is a modular design, and we have selected modules to fill our particular need. The total system that can be assembled has considerably more versatility than the system described for this application.

To evaluate the instrumental system for dirt counting, eight lint lots were selected representing four different dirt levels. The levels were as follows:

Low dirts	<5
Lower-midrange dirts	10–50
Upper-midrange dirts	50–75
High dirts	>100

Duplicate AOCS Official Cellulose Yield Cooks were made for each of the eight lots, and a 20-gram sample of each cook was bleached by our regular quality-control (QC) procedure. The duplicate yield cook samples were sheeted by two different procedures. The QC visual dirt count and the instrumental PiMC counts were made on each handsheet.

The instrument analysis involved reading 42 nonoverlapping fields on each side of the handsheet. Each field measured 29.5 mm by 41 mm, and the total of 84 fields was equivalent to about 70% of the total sheet surface area. The average time required to read both sides of a handsheet and record the final results was about 3 minutes. The standard deviation of the instrumental method as calculated from these results was 8.15%. This compared quite favorably with the approximately 26% standard deviation for our present visual QC procedure. Utilizing a logarithmic treatment of the data, the correlation coefficient between the QC and the PiMC dirt count was 0.96.

It should be pointed out that the quality of the

test sheet is critical to obtaining good results with this test. It is important to eliminate faults in the sheets such as holes, crevices, or lumps. Spurious information can result from shadows introduced by such faults. The cracks or crevices which result upon shrinkage of the sheet during drying can lead to such shadows and, in fact, different dirt areas are indicated between wet and dry sheets. Figure 2 shows the relationship between the two procedures using both wet and dry sheets. It is interesting that the instrument finds a higher dirts area for the never-dried sheets than for the dry sheets, but the more important finding is that the standard deviation calculated for data for the never-dried sheets is lower than for the dry sheets. For this reason the procedure for further work was standardized on reading the never-dried sheets.

Table 1 gives an indication of the precision of the instrument analysis of dirts. For this work we took 13 sheets, numbered each side of the sheet, and read each side twice. In each case the handsheet was removed from the mechanical stage and then replaced on the stage for the second test. The deviation in individual values from the average of the pair of tests for each of the sheets was just slightly over 1%.

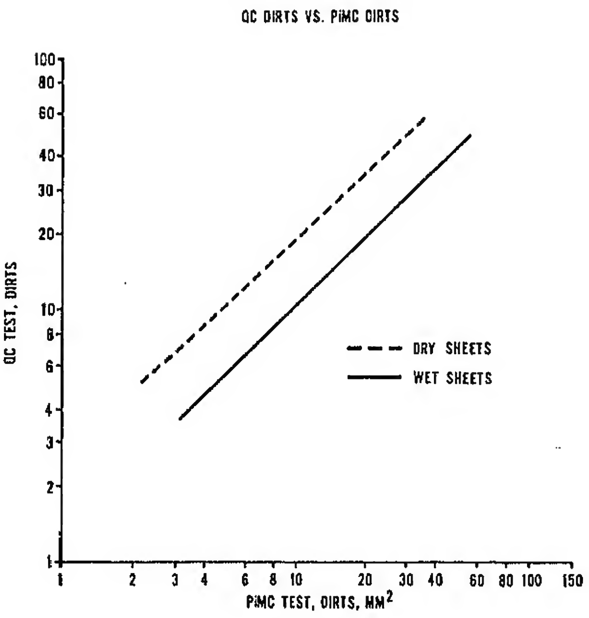

FIGURE 2.—QC dirts vs. PiMC dirts for dry sheets and wet sheets.

TABLE 1.—*Dirts in wet, quality-control linters handsheets*

Sample	Side 1		Side 2	
No.	Test 1	Test 2	Test 1	Test 2
1	89	88	75	76
2	269	268	320	312
3	20	21	56	53
4	30	29	38	38
5	99	101	92	90
6	78	78	87	88
7	82	84	58	59
8	116	123	119	120
9	87	86	106	110
10	37	38	44	40
11	54	55	64	64
12	291	288	332	322
13	94	89	92	92

Deviation from average of pairs±1.13%.

To assure ourselves that this test was not just a laboratory curiosity, the instrumental dirts test was used in parallel with the routine quality-control dirt count for some 350 lots of lint. The results of these tests gave added confidence in both the precision of the instrument analysis of dirts areas and the correlation between our present QC dirts test and the new method. The decision was then made to catalog all lint receipts based on both the conventional QC dirts test and also the instrument analysis. We have now tested over 1,100 lots of lint, and the correlation between the Millipore dirt count and the present QC dirt count is shown on the figure 3. The correlation coefficient is 0.93. The equation of the line represented here is log Dirts QC=0.8839 (log Dirts PiMC) +0.104. The standard deviation for data about this line is 0.157, which is also stated in terms of a logarithm. The dash lines show the limits for plus and minus 1 standard deviation from the calculated line. Since the data have been handled in terms of logs, the variability about a point will vary with the level, but in general terms the scatter of data about a point would be about 30% to 40% of the value. At first glance this value looks high; however, it must be viewed in the context that we are correlating data from two tests, one which has a standard deviation of approximately 26% of the value and one which has a standard deviation of approximately 8% of the value.

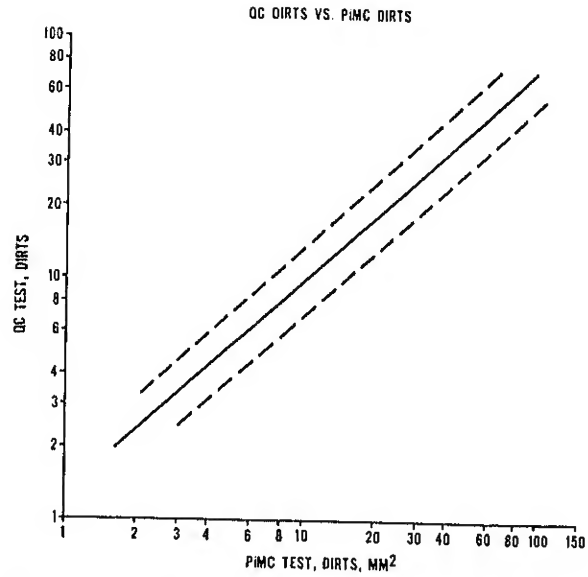

FIGURE 3.—Correlation between QC dirts and PiMC dirts, showing standard deviation about the line.

Obviously, the major component of variability is in the test result that we are trying to replace.

At this point we have concluded that the new instrument test method has considerable merit, and we have taken steps to purchase the equipment from Millipore to install the test on a routine basis. We feel that it could, likewise, be of value to others, and we have taken steps to define calibration procedures that should make it possible to calibrate a PiMC image analyzer system in a remote location in such a way that the results are comparable between various units. I do not plan to go into the details of the calibration procedure at this point; however, the procedures will be made available to anyone who has an interest in them. Through the cooperation of Millipore, two other PiMC analyzer system installations have been checked with this calibration procedure. Comparable results have been obtained with these units.

STATUS OF RESEARCH ON COTTON LINTERS TO DEVELOP PRODUCTS THAT WILL MEET FLAMMABILITY STANDARDS [1]

By Paul A. Koenig,[2] Julius P. Neumeyer,[3] and Nestor B. Knoepfler[3]
(Presented by Nestor B. Knoepfler)

On September 9, 1966, the Congress enacted the Highway Safety Act. Under this legislation all materials used in the interior of automobiles and other passenger vehicles are required to pass a flammability standard.

On December 14, 1967, amendments to the Flammability Textiles Act of 1952 were passed by the Congress. These amendments broadened the scope of the original act to include home furnishings such as mattresses and upholstered furniture.

On January 8, 1971, the Secretary of Transportation announced a standard for flammability of automobile interior trim materials. This standard is identified as Motor Vehicle Safety Standard 302 (MVSS 302). All automobile interior trim materials manufactured after May 1973 are required to meet the standard. MVSS 302 employs a horizontal burning rate test on both the individual components and a mockup of a complete seat structure (fig. 1). The maximum acceptable burn rate is 4 in/min.

A standard for mattress flammability was published by the Secretary of Commerce on June 7, 1972. This standard, FF4-72, requires that all mattresses manufactured for sale in the United States be able to resist ignition when tested with a burning cigarette. Tests are performed (by placing the cigarette) on the bare mattress surface and between two sheets (fig. 2). Each surface location that exists on the mattress—for example, tape edge, flat surface, quilted or tufted areas—must be tested with at least three cigarettes. Thus a mattress with three different surface locations would be tested with a minimum of eighteen cigarettes, nine on bare mattress testing and nine on the two sheet configuration. If the mattress burns for more than 5 min after the cigarette is completely consumed or if the char extends beyond 2 in from the longitudinal center of the cigarette, the mattress fails. All mattresses marketed after June 7, 1973, have

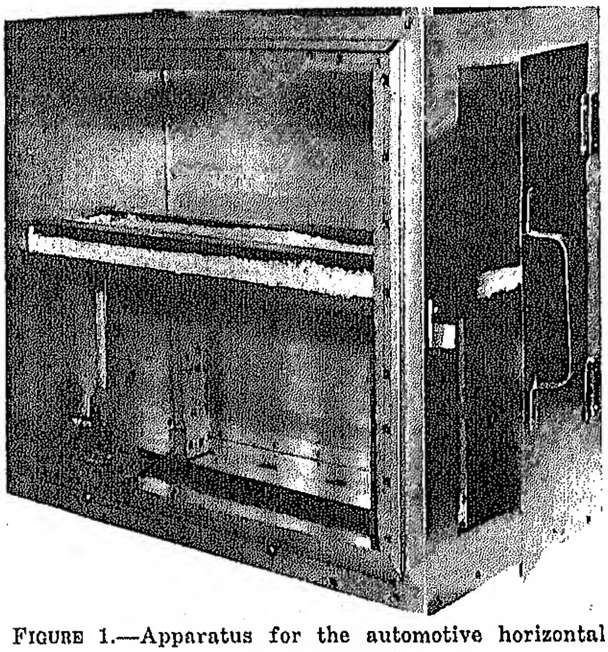

FIGURE 1.—Apparatus for the automotive horizontal burn rate standard.

[1] This work is being carried out under a cooperative agreement with the National Cotton Batting Institute and under a memorandum of understanding with the Textile Fibers and ByProducts Association and the National Cottonseed Products Association.

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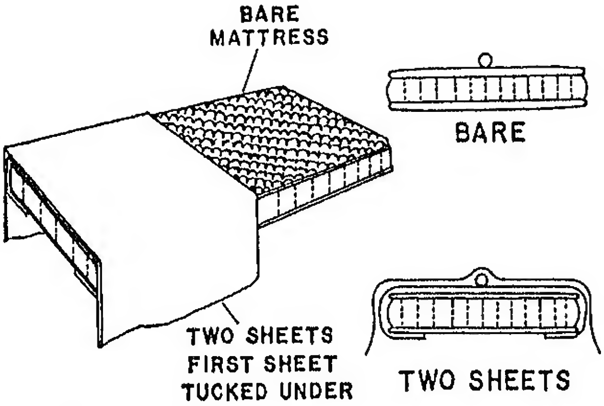

FIGURE 2.—Cigarette standard for mattresses.

to meet the standard. It is interesting to note that the Department of Transportation has chosen a standard for flammability of automobile trim that is entirely different from that selected by the Department of Commerce for mattresses.

From a research point of view there are some serious doubts that the standards really provide consumer safety to the degree that is technologically possible. Using the automotive standard, for example, we have evaluated upholstery fabrics that have burning rates by the standard procedure of less than 3 in/min. However, some of these samples, when tested in the vertical position, have burning rates in excess of 20 in/min. This is rather disconcerting since, in American-built automobiles, approximately 60% of the seat surface is in the verticle position.

Likewise, in the mattress standard no provision is made for the employment of an open flame as the source of ignition. The standard passes highly flammable polyurethane foam, but fails cotton batting. This occurs because, where a cigarette is used as the ignition source, the polyurethane foam tends to melt and form a void and thus insulate the underlying material. In cotton mattresses no void forms, and the cotton enters a state of smoldering combustion. Where an open flame is used as the ignition source, the polyurethane foam melts, ignites, and burns furiously. On the other hand, cotton mattresses exposed to an open flame usually flame briefly and then subside to a slow smoldering combustion.

Regardless of the divergence in the standards, cotton batting must be made to comply if it is to be used in cushioning materials. With respect to automobile end-uses, a considerable amount of the technology relating to flame-retardant cotton products can be applied.

For the Cotton Flote system, products that pass MVSS 302 have been made by incorporating urea phosphate, borated amido polyphosphate, propyl ammonium phosphate, or diammonium phosphate into the treating formulation. As a general rule the add-on of flame retardant required is about 8% to 10% by weight of the cotton treated. For Cotton Flote the cost of obtaining a degree of flame retardance sufficient to meet the standard is about 1.5 cents per pound.

For conventional cotton batting, that is, batting that receives no resin treatment, it is necessary to apply the flame retardant by an immersion process while the fibers are still in raw stock form. Spray techniques and other methods of applying the flame retardant to the fibers during mechanical processing usually do not achieve a sufficient degree of uniformity of chemical distribution. Other considerations such as the size and type of drying equipment makes these processes less economically attractive than immersion.

The chemical systems found suitable for the treatment of raw stock to meet MVSS 302 include urea phosphate, borated amido polyphosphate, propyl ammonium phosphate, and diammonium phosphate. The cost of rendering conventional cotton batting flame retardant amounts to about 2.5 and 3.0 cents per pound.

Some problems in meeting MVSS 302 still exist. For example, in figure 3 it will be noted that even though the cotton batting passes when tested as a component of an automobile seat assembly, divergent results are obtained when the same material is covered with an upholstery fabric. Note that the char length of the treated batting is not measurable by the standard and that the material with a zero burn rate readily meets the standard. On the other hand, untreated batting charred its entire length and had a burn rate of about 5 in/min, which would make it unacceptable by the standard. The upholstery fabric used for this demonstration is a cuprammonium antron (rayon). Note that when tested by itself, it charred its entire length, but it would pass the standard since it has a burn rate of about 3 in/min. When this fabric is assembled with the batting as it would occur in a seat, the char length obtained for the treated batting-rayon was greater than that for the untreated batting-

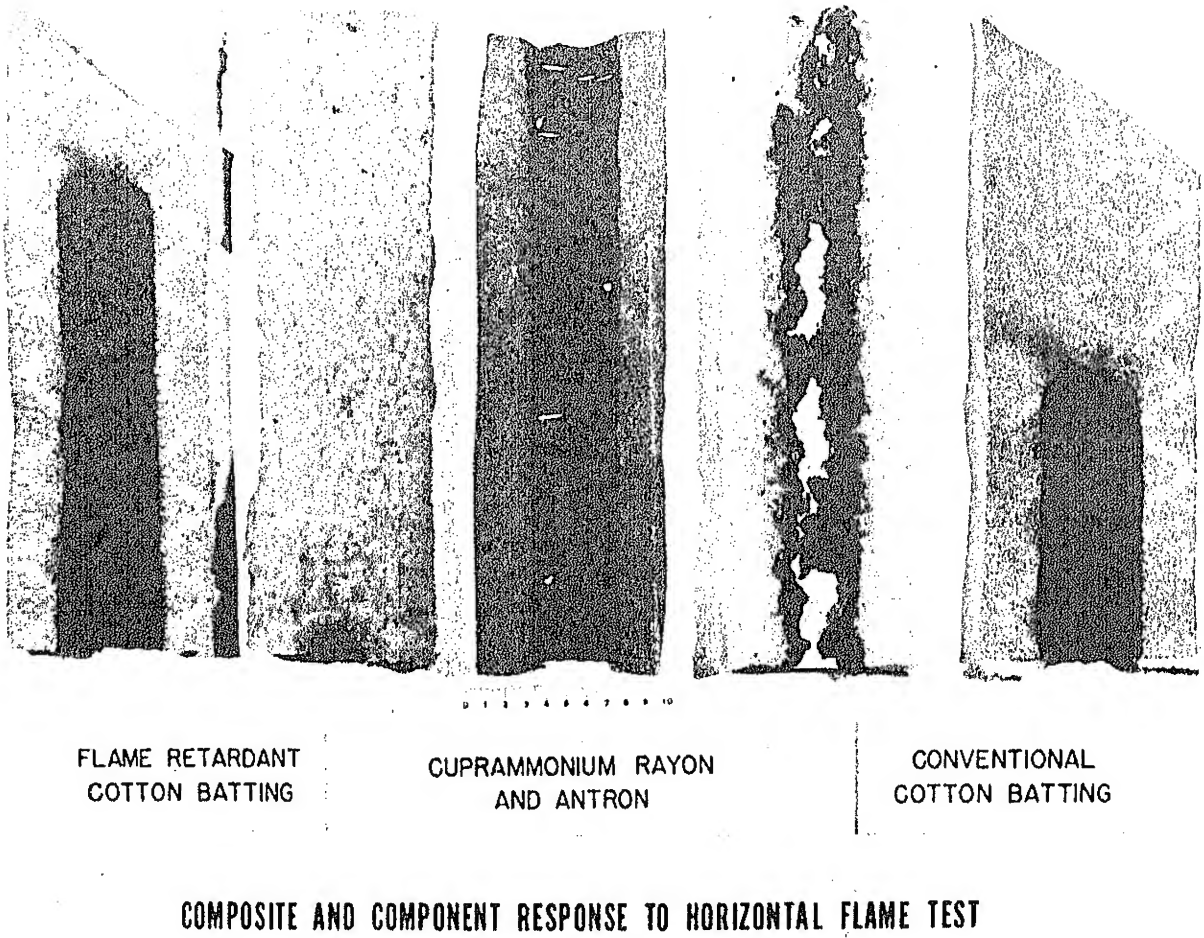

FIGURE 3.—Composite and component response to horizontal flame test.

rayon fabric combination. Both of these combinations pass the MVSS 302 with burn rates of less than 4 in/min. The untreated batting-rayon fabric combination would, however, be rejected by the standard since it failed to pass as an individual component. It is well known that the performance of composites in which dissimilar materials contact or are close together cannot be predicted upon the performance of the components. More research is needed to explain this inconsistency.

Most of our recent research has been directed toward the development of cotton batting products that would meet the mattress flammability standard DOC FF 4-72. The problem here is much different and more difficult than the problems of flammability as defined by MVSS 302. The balance of this presentation will, therefore, concern itself with a discussion of the problems of mattress flammability as related to DOC FF 4-72 and report on the progress made to date in solving this vexing problem.

When a lighted cigarette is placed in contact with a mattress, the combustion that ensues if ignition occurs is usually of a smoldering type. That is, the reaction proceeds in a glowing manner in the absence of flaming.

Flaming combustion is characterized by a rapid oxidation of degradable material. Flaming combustion takes place in the gaseous phase and involves the burning of gaseous byproducts from the thermal degradation of the material. Classical flame-retardance theory envisions an interference with the course of the pyrolysis reaction to direct the formation of increased amounts of solid byproducts and reduced amounts of flammable gaseous byproducts. This results in a slowing of the reaction rate to the point where insufficient thermal energy is produced to sustain the reaction.

Smoldering combustion is an entirely different kind of a reaction. It is defined as a direct oxidation of solid material. It proceeds at a very slow rate in comparison with flaming combustion. The temperature of the reaction in smoldering combustion is generally considered to be about 200° F higher than the reaction temperature in flaming combustion. Sometimes the word "afterglow" is applied to smoldering combustion. It should be clearly understood that this concept is incorrect. Smoldering combustion is unrelated to and quite different from flaming combustion in its mechanism. Flaming combustion that precedes smoldering combustion merely supplies sufficient energy to initiate smoldering combustion. Such energy can also be supplied by, for example, a cigarette or an electric probe completely in absence of flaming. Of particular importance in the development of cigarette-resistant mattresses is the recognition that chemical treatments that are of a classical type, that is, those which change the chemical oxidative reaction to the formation of greater amounts of solid byproducts, are contraindicated in smoldering combustion. In practice it has been found that the classical flame retardants actually provide more fuel for solid-state combustion.

In our research, we have found that smoldering combustion as induced in a mattress is self-sustaining as long as the temperature within the structure exceeds 750° F. This temperature is readily attained by smoldering combustion. In fact, temperatures in excess of 1,000° F are common, even where the filling material has been treated with a classical flame retardant. These high temperatures persist because a mattress structure consists of an excellent insulator, cotton batting, and the covering of ticking further reduces the amount of heat that can be convected, conducted, or radiated.

With the parameters described above, it should be apparent that the heat transfer environment as it occurs in a mattress plays an important part in the devising of a treatment for cotton batting which will insure that the finished product will pass DOC FF 4-72.

One rather promising approach for preventing ignition of cotton batting within a mattress structure is back coating the ticking with a suitable polymer. The thermal characteristics of polymers affect their ability to dissipate heat by increased thermal conductivity and to absorb heat during melting or degradation. In some instances it has been possible to improve the ability of back coated tickings to inhibit the ignition of the underlying batting by incorporating metallic pigment such as aluminum. As a general rule, it appears that unless the amount of aluminum pigment or other additives or fillers is quite high, the major part played in heat dissipation can be attributed to the polymer.

Eight polymer systems have been evaluated as back coating agents for mattress tickings. Each was evaluated by the mattress standards wherein a lighted cigarette was placed in the valley of the tape edge on a bare minimattress. The best results were obtained with either vinyl acrylic or styrene-butadiene. Intermediate performance was imparted by phosphorylated polyvinyl chloride, ethylene polyvinyl chloride, and polyvinyl acetate-acrylate-maleate, while the poorest performance was obtained with polyvinyl acetate, polyurethane, and polystyrene. It should be emphasized that the polyurethane was applied as a film from a water-based emulsion; it should not, therefore, be equated with polyurethane foam.

For conventional cotton batting a number of approaches to the impregnation of the fibers have been tried. From an overall cost and efficiency consideration, it appears that immersion and squeeze-roll techniques offer the best promise of obtaining uniform treatment. Based upon our research along these lines, Lummus Industries of Columbus, Ga., has constructed a demonstration prototype of an impregnation range and dryer which they will offer to the cotton batting industry for the treatment of raw stock.

Previous research has shown that as a general rule the application of flame-retardance treatments to cotton results in a lowering of the temperature at which flaming combustion can be induced. Instrumental methods of analysis of the course of pyrolysis indicate that some of the chemical systems that are effective as flame retardants raise the temperature at which smoldering combustion is induced. Of these systems, the most promising involve reagents that coat the fiber at some stage of the pyrolysis reactions. The treatments selected for evaluation included phosphoric acid, urea phosphate, THPC-amide, an intumescent formulation containing a phosphorylated phenolic resin, and borax-boric acid, all of which can conceivably coat the fibers at some time during the course of pyrolysis. Re-

search was carried out to determine the amount of add-on of particular flame retardants that would be needed for cotton batting products to pass the cigarette standard once they were installed in mockup minimattresses. The results of these tests are presented in tables 1, 2, and 3.

For the phosphoric acid treatments, 4.1% phosphorus was required to pass the single-cigarette test and 9.2% was needed for the two-cigarette test. In both cases the total add-on was unfeasibly high and the filling material underwent excessive acid degradation. In the urea-phosphate treatments less phosphorus was required, 2.52%, with the assistance of 8.36% nitrogen. The total add-on required was higher than for phosphoric acid and considerable degradation still occurred. The THPC-amide treated batting passed the single cigarette test with as little as 1.59% P and 5.27% N. Again the total add-on was unfeasibly high, and excessive degradation was evident. Even with as high as 54% total add-on the structure continued to fail the two-cigarette test.

TABLE 1.—*Effect of phosphoric acid-treated batting on cigarette-ignition of mattresses*

Phosphoric acid (%)		Ignition test	
Add-on	Phosphorus content	1 cigarette	2 cigarettes
5.5	1.58	I	I
9.5	2.36	I	–
15.3	3.49	I	–
21.4	4.10	N	I
27.0	6.56	N	I
39.9	9.20	N	N

I=Ignition.
N=No ignition.

TABLE 2.—*Effect of urea phosphate-treated batting on cigarette-ignition of mattresses*

Urea phosphate (%)			Ignition test	
Add-on	Phosphorus content	Nitrogen content	1 cigarette	2 cigarettes
3.83	0.66	2.48	I	–
9.95	1.39	4.54	I	–
15.3	1.85	6.05	I	–
22.8	1.90	7.41	I	–
29.5	2.52	8.36	N	I
36.3	2.63	9.59	N	I

I=Ignition.
N=No ignition.

TABLE 3.—*Effect of THPC-amide-treated batting on cigarette-ignition of mattresses*

THPC-amide (%)			Ignition test	
Add-on	Phosphorus content	Nitrogen content	1 cigarette	2 cigarettes
10.9	0.71	2.45	I	I
20.0	1.21	3.80	I	I
31.8	1.59	5.27	N	I
43.2	1.77	5.85	N	I
54.0	2.21	8.03	N	I

I=Ignition.
N=No ignition.

Phosphorus-containing compounds are considered to be effective inhibitors of both flaming and glowing combustion. Their value has been explained as an influence on the primary degradation reaction via a reduction in the production of volatiles and thus a reduction in flaming combustion. Little is known about the details of their effectiveness in glowing combustion. One theory holds that a viscous, sticky, melt-type substance called a polyacid formed on the decompositon of the phosphorus-containing material provides a physical barrier surrounding the individual cotton fibers. Another theory envisions a catalytic alternation of the solid-phase oxidation process. If the former is controlling, then the activity which contributes to forming a barrier must effectively occur at temperatures below which smoldering can be induced. If the latter catalytic action is dominant, then it must take place during the smoldering or glowing combustion.

Differential thermal analytical techniques disclose that phosphoric acid slows down the rate of both smoldering reactions; thus, more time is available to convect, conduct, radiate, or disperse the heat generated. With phosphoric acid as the treatment it has been possible to demonstrate that the heat of the first reaction can be reduced to the point where no glowing combustion is initiated. The viscous film formed by the polyphosphoric acid is available in sufficient volume to coat the fiber surfaces only at high add-ons.

Differential scanning calorimetry has been shown that at high add-ons of phosphoric acid heats of reaction as low as 900 cal/g are obtained. Such materials pass the cigarette test. Where urea phosphate is used in the treatment, heats of reaction from 1,300 to 1,500 cal/g are obtained.

This probably explains why phosphoric acid is more effective in preventing cigarette ignition of mattresses than urea phosphate.

Another approach to the achievement of a film or barrier to inhibit the ignition of the cotton batting by a cigarette placed on the ticking involves the use of intumescents (table 4). This technique allowed the production of samples of cotton batting having add-ons of less than 10% by weight of the cotton fibers which passed the single-cigarette test on a bare mattress. An add-on of 13.5% was needed to pass the two-sheet requirement of the mattress standard.

Borax-boric acid mixtures have some properties that approach those of intumescents. In borate-containing systems, the chemicals swell into a frothy mass upon heating, lose their water of crystallization, then fuse into a clear melt. The clear melt probably coats the fibers and protects them from thermal energy, again in a barrier effect, probably a similar mechanism to that noted for phosphorus compounds discussed above. With an add-on of as little as 4.5% by weight of borax-boric acid, mock-up mattresses containing the material passed the single-cigarette test (table 4). With an add-on of 11.8% borax-boric acid, treated cotton batting products could pass a test run with two cigarettes side by side.

In a series of tests the ratio of borax to boric acid was varied at the 15% add-on level. The results of this work (table 5) confirm that the borax was effective only in the prevention of flaming combustion and that boric acid, while

TABLE 4.—*Effect of intumescing agent and borax-boric acid solution treatment of batting on cigarette-ignition of mattresses*

Add-on (%)	1 cigarette	2 sheets	2 cigarettes
Intumescing agent:			
4.5	N	I	I
11.8	N	N	N
16.2	N	N	N
10.0	N	–	I
13.5	N	–	I
Borax: boric acid (7:3):			
27.7	N	I	I
32.5	N	–	N
36.6	N	–	N

I=Ignition.
N=No ignition.

TABLE 5.—*Effect of treating batting with various borax-boric acid solutions on cigarette-ignition of mattresses*

[Cigarette test on tape edge of minimattresses; borax-boric acid mixtures on batting at 15% add-on]

Borax:boric acid ratio	1 cigarette: Bare mattress	1 cigarette: Between 2 sheets	2 cigarettes, bare mattress
0:1	N	N	N
6:5	N	N	I
7:3	N	N	I
1:0	I	I	I

I=Ignition.
N=No ignition.

inefficient in preventing flaming combustion, was quite effective in preventing smoldering combustion.

Samples of cotton batting treated with as little as 5% by weight of boric acid and installed in minimattresses passed the mattress flammability standard, and at a 10% add-on level could pass a test where two lighted cigarettes were placed side by side. Two cigarettes are used to obtain an estimate of the margin of safety over and above that required by the standard.

Both the intumescent and the borax-boric acid treatments supplied considerably more protection against cigarette ignition of mattresses than any of the classical Lewis acid treatments so far evaluated. They effectively reduce the rate of the first, or flaming, reaction and increase the temperature at which it occurs. Furthermore, they increase the temperature of onset of the second reaction usually associated with smoldering combustion to over 900° F. Because the temperature at the interface between the cigarette and the mattress is only about 750° F, the initiation of smoldering combustion is avoided.

Since the current research effort is being directed toward meeting the requirements of DOC FF 4-72, consideration of means of obtaining both flame retardants and smolder resistance have been subordinated to the urgent need for smolder resistance.

Recent research has therefore concentrated upon the employment of borate-containing compounds as the treatment for raw stock. Add-on levels of 5%, 7.5%, 10%, and 15% ammonium borate were evaluated. The results as shown in table 6 indicate that an add-on level of about

10% of ammonium borate is sufficient to pass DOC FF 4-72. The presence of ammonium borate did not significantly affect the properties with the exception of the heat set of the batting that was ultimately produced, as can be seen from table 7. Sodium borate was evaluated at the 5%, 10%, and 15% add-on level as shown in table 8. With this chemical system an add-on level of about 10% by weight of the cotton treated seemed to be adequate to pass DOC FF 4-72. The presence of the sodium borate did not significantly affect the performance characteristics of the batting that was produced from the treated raw stock, as is shown in table 9. Note that the heat set was not as drastically affected with sodium borate as with ammonium borate. Table 10 shows the results obtained when sample mattresses containing 10% boric acid were treated by DOC FF 4-72. The middle sample contains 2% of ammonium carbonate, which is used to improve the solubility of the boric acid and permit the rapid mixing of the formulation even in cold water. For comparison, the performance of the sample containing borax-boric acid (table 11) shows that these treatments did not significantly change the physical characteristics of the batting products compared to untreated raw stocks, again with the exception of heat set. Where proper impregnation of the fibers has been obtained during processing, the amount of boric acid lost is minimized during subsequent garnetting.

Because it would be prohibitively expensive to carry out the research on full-scale mattresses, the research team has designed a minimattress structure. With such miniature mattresses it is possible to screen a wide variety of treatments and back-coating formulations at a reasonable cost in a standard laboratory hood.

TABLE 6.—*Effect of ammonium borate-treated batting on cigarette-ignition of mattresses*

[Cigarette test on tape edge of minimattresses conditioned 24 h at 70° F, 50% RH]

Ammonium borate in solution (% add-on)	1 cigarette: Bare mattress	1 cigarette: Between 2 sheets	2 cigarettes, bare mattress
5.0	N	N	I
7.5	N	N	I
10.0	N	N	N
15.0	N	N	N

I = Ignition.
N = No ignition.

TABLE 7.—*Performance characteristics of 2.0-lb/ft³ batting made from ammonium borate-impregnated raw stock*

Standard test	Untreated control	Ammonium borate at— 5%	7.5%	10%	15%
Recovery in 4 min (%):					
60% RH	68.8	70.8	68.8	64.7	65.2
100% RH	53.1	51.9	54.5	50.4	48.9
Heat set at 30 min (%)	21.7	50.0	46.4	48.3	51.9
Compression at 1 lb/in² (%)	67.5	64.6	62.0	62.1	62.8

TABLE 8.—*Effect of sodium borate-treated batting on cigarette ignition of mattresses*

Sodium borate[1] in solution (% add-on)	1 cigarette: Bare mattress	1 cigarette: Between 2 sheets	2 cigarettes, bare mattress
5.0	N	I	–
10.0	N	N	N
15.0	N	N	N

I = Ignition.
N = No ignition.
[1] Especially compounded 0.28 Na_2O/B_2O_3 ratio.

TABLE 9.—*Performance characteristics of 2.0-lb/ft³ batting made from sodium borate-impregnated raw stock*

Standard test	Untreated control	Sodium borate at — 5%	10%	15%
Recovery in 4 min (%):				
60% RH	68.8	67.9	66.5	69.8
100% RH	53.1	49.3	47.2	48.5
Heat set at 30 min (%)	21.7	40.0	36.0	33.3
Compression at 1 lb/in² (%)	67.5	62.5	63.0	61.9

TABLE 10.—*Effect of various batting add-ons of borax-boric acid solution on cigarette-ignition of mattresses*

% Add-on: Borax	% Add-on: Boric acid	1 cigarette: Bare mattress	1 cigarette: Between 2 sheets	2 cigarettes, bare mattress
0	10	N	N	I
0	[1]10	N	N	N
5	5	N	N	I

I = Ignition.
N = No ignition.
[1] 2% ammonium carbonate added to improve solubility of boric acid.

TABLE 11.—*Performance characteristics of 2.0-lb/ft³ batting made from boric acid-impregnated raw stock*

Standard test	Untreated control	Boric acid 10.0 %	Boric acid 10.0 %[1]	5:5 boric acid (10.0 %)
Recovery in 4 min (%):				
60% RH	68.8	69.8	67.9	72.6
100% RH	53.1	50.4	50.4	48.4
Heat set at 30 min (%)	21.7	39.1	42.3	34.6
Compression at 1 lb/in² (%)	67.5	63.3	64.1	64.5

[1] 2.0% ammonium carbonate added to improve solubility.

It is our understanding that a recommendation has been made to the National Association of Bedding Manufacturers by a member of the National Cotton Batting Institute that the Department of Commerce be asked to permit the use of minimattresses instead of full-scale mattresses for the DOC FF 4-72 testing. The use of small-scale mattresses would certainly reduce the cost of testing and would be a boon to the small mattress manufacturer.

In summary, it is of major concern to the cotton batting industry that they will be required to produce products which have to meet standards which are quite diverse in their demands. In all probability, if a manufacturer is producing cotton batting for both the automotive and mattress markets, he will have to have separate production lines and separate treatments.

PANEL DISCUSSION: UNACCOUNTABLE OIL LOSSES

J. M. JOHNSON:[1] The problem of unaccountable, or hidden, oil losses seems to have come up with some regularity through the years. I suppose that the greatest impact of this problem was felt in the middle 1950's when conversion from hydraulic extraction took place to a significant extent in the industry.

To state the problem in simple terms, an unaccountable oil loss means that the sum of the oil produced plus the oil in products is less than the oil indicated in the seed by laboratory analysis. This unaccountable loss may occur in one or more of three different ways: an incorrect sampling and analysis of the seed as received for oil content; an incorrect sampling of the products which would misrepresent the amount of oil which is lost in the materials, such as meal, lint, and hulls; or an incorrect analysis of the oil content of the products.

If seed receipt samples are not representative of the seed crushed, the official analysis may show more oil than is actually available. Less oil will be produced than is expected, so you have an unaccountable loss. Also, laboratory analyses may be wrong. To minimize this problem, our company has a continuous auditing procedure whereby identical seed samples are analyzed by two or three laboratories, including our own lab, and the results are checked. It takes a very small content error through poor lab techniques to account for several pounds of oil.

In the sampling of products, unless these samples truly represent actual results, a distorted picture often may occur. As an example, each one-tenth percent oil in meal represents roughly 1 pound of oil per ton of seed. Here again, the human factor is present. We depend upon our people to either take a sample or to handle the sample. Sometimes these samples do not reflect the actual oil losses which occur.

Concerning incorrect laboratory analyses of oil losses in products, there may be the same problem concerning lab techniques and human errors as mentioned in the analysis of seed. Just as an incorrect sampling of products might indicate a lower-than-actual loss, an incorrect indication of the amount of oil in these samples would do likewise. There is another indicated loss in products, however, which standard laboratory procedures will not indicate. Apparently in the early 1950's, as screw-press operations became popular, lower-than-expected oil yields were being experienced with mechanical screw presses than with the old hydraulic method. Several discussions and papers at these and other meetings in past years indicated that 2 to 5 pounds of unaccountable oil losses occur in mechanical screw-press extraction as compared to the hydraulic. Laboratory work done by our company and by others indicated that some oil was found in cake in mechanical screw-press extraction which could not be indicated with the normal laboratory extraction procedure. I assume that these hidden or unaccountable losses have been accepted by the members of the industry and added into their indicated losses to figure out their predicted yields.

Of course, there are other factors that can reflect an unaccountable oil loss. Bad accounting, theft, and so forth will result in less oil in the tank than expected. Usually this will also reflect a shortage of other products and an excessively high material loss. Long periods of seed storage will also reflect a lower-than-expected oil loss, but here again, losses in other products will be reflected, and a loss in oil products can be explained.

WALTON SMITH:[2] In 1957, when I attended my first Oilseed Processing Clinic, the major topic of conversation was hidden oil mill losses. Some people call them hidden oil mill losses; others, unaccounted-for oil losses. This was a prob-

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lem at that time, just after the advent of the screw press and expeller installations at a lot of oil mills.

Some people said we were burning the oil in the screw presses. We heard things talked about like x-factors, but I never have been sure that we burned any oil. It did cause a lot of us to start concentrating on some of our techniques—taking and handling samples, protection of samples prior to their reaching the laboratory, and that sort of thing—and we thought that within our own company, anyway, we had this problem in hand. But we had some disappointments this past season that caused us to wonder really what happened.

We had ammonia disappearances and disappointments in various places. We had oil disappearances in various places that we couldn't explain. At one of the locations where it was so pronounced, never have we been in a better position to check all phases of our operaton, and never were we able to find a satisfactory explanation.

At this particular mill, we had during the season taken something like 171 seed samples for analysis, and the averages of all those seed analyses indicated a real close check between two laboratories. We sent off 120 duplicate meal samples and again we got a real close check. We checked out our railroad scales, and could find nothing there. The truck scales checked all right.

We have made a practice for a number of years of weighing our sacked meal and hulls across the scales, weighing the truck light and heavy as a check against our sacking scales. We could find nothing here that could explain a loss of this nature. We had a substantial inventory of bulk hulls on hand, and we had our people at the mill sample them, recognizing, of course, that this very likely couldn't be representative of the whole season's production. The sample that we took from inventory checked very closely with the average for the season. We had samples analyzed at another laboratory, and again it was relatively close, maybe a little higher than the average for the season, but not nearly enough to explain a loss of this magnitude. Moreover, we had no unusual loss in the cleaning room trash.

Since that time, we have done several things in an attempt to find where these losses were occurring.

We found that some of our locations were using various methods for calculating tonnage crushed, and although there was no oil loss, the calculations made it appear that there were.

We are insisting that our mills keep a tabulation of their seed receipts analyses average. We also keep one in New Orleans, and we check periodically to be sure that we are in agreement. We are continuing to check-weigh our sacked products, meal, and hulls going across the truck scales as a check against our sacking equipment.

We set up this year at all of our locations a method, a so-called ticket system, to be sure that every truckload of cottonseed that went across our scales also went across at our unloading station. We are sending a check sample of cottonseed to an additional laboratory for each particular mill. Every 500 tons of receipts, we are sending a check sample. We are doing the same thing on our cottonseed meal as a check against the analytical work on that.

We have stressed again the importance of properly taking cottonseed samples, meal samples, and hull samples and of properly handling them after they have been taken to be sure that we know what we are buying.

We are weighing, sampling, and having analyzed each load of trash that is removed from the process from each mill to be sure that we know what we are hauling off. In addition, some of the air polluton regulatory agencies are getting on a process weight basis and we need that information for a sample material balance.

We don't know yet, of course, how we are going to come out this year because most of our mills are still operating. One mill has finished crushing for the season, and results there were disappointing.

The disappearance of oil last year was substantially higher than normal—I would say on the order of 3 pounds higher than normal. The ammonia recovery last year was up to as much as 2% in some mills and 3% lower at other locations than we normally would expect. We had, on a dry basis, more solids lost last year than we would normally expect.

JACK HUGHES:[3] My subject is losses in the cleaning room. At one time we got in very few unginned lots of cotton, but this past season, we got in about 20 pounds to the ton of unginned lots of cotton. We have put this through a Fort

[3] Superintendent, Yazoo Valley Oil Mill, Inc., P.O. Box 1320, Greenwood, Miss. 38930.

Worth seeder that runs 600 r/min to recover the seed. This has been working now about a year, and it works very well. We think we are picking up about 3 pounds of oil with this system.

CARTER FOSTER, JR.:[4] I don't think the laboratories are causing the oil losses, but I am wondering, when the mills take their average sample analyses for the year, do you take it on weighted averages or do you just add up your sample sheets. How much variance do you get in truckloads?

MR. SMITH: We have used weighted averages but we never have accomplished anything by this. The only time a weighted average would be much different from a simple average is in the case where a drastic change in seed quality occurred somewhere in the middle of the season.

MR. FOSTER: The reason I asked that question was because one mill I know came up with that and used their seed average and when we averaged it out he had more seed. They were about a percent lower than they would have been by taking a weighted average. There are many variables.

J. W. KIDD:[5] We have heard from all the panel members. I should now like to relate an experience that I had at my mill last year.

I don't know what took place—bacterialization, mold invasion, a combination of the two, or something else.

I am describing the conditions in North Alabama, between about October 19 and the time of our first freeze. I think that conditions in Georgia and Mississippi were somewhat similar. We had not had any rainfall for 2 or 3 weeks. The cottonseed had begun to dry when suddenly the moisture content began to increase very rapidly. This continued as seed was sampled for approximately 10 days or longer. I can't tell you exactly when this took place.

We had very foggy mornings, warm foggy days, and very high humidity. The cotton was picked half green, half wet. It stayed on the wagons at the gins for 24 hours to 3 days, and in my opinion something happened to the cottonseed on the seed wagons, waiting to be ginned. Whatever that condition might be continued into the mill and was not stopped by cooling with air. We had no cool weather. We had nothing but wet, warm, muggy conditions. When the seed was extracted, there was no oil. In my opinion, part of what happened to each of us last year was an invasion either by mold or by bacteria or a combination.

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